PRELIMINARY INSTRUCTION BOOK

FOR

NAVY MODEL SO-4 RADAR EQUIPMENT

SHIPS 295

CONFIDENTIAL

(NON-REGISTERED)

MANUFACTURED BY

RAYTHEON MANUFACTURING COMPANY

WALTHAM, MASSACHUSETTS, U. S. A.

FOR

U. S. NAVY DEPARTMENT — BUREAU OF SHIPS

CONTRACT: NXss-39240 — 10 DECEMBER 1944

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BUREAU OF SHIPS
WASHINGTON 25, D.C.

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RECORD OF CORRECTIONS MADE

Change No.	Date	Signature of Officer Making the Correction

TABLE OF CONTENTS

SECTION I. DESCRIPTION

Paragraph		*Page*
1.	General	1–3
2.	Basic Principles of Operation	1–3
3.	List of Included Units	1–5
4.	Location of Components	1–8
5.	Cabling Designations	1–8

SECTION II. INSTALLATION

1.	Power Requirements	2–1
2.	Installation Layout	2–1
3.	Housings and Supports	2–1
4.	Installation Requirements	2–1
5.	Cabling and Connections	2–2
6.	Tubing of Equipment	2–3
7.	Check-up Following Installation	2–3
8.	Elimination of Interference	2–4

SECTION III. OPERATION

1.	General	3–1
2.	Starting the Equipment	3–1
3.	Stopping the Equipment	3–1
4.	Operating Adjustments	3–1
5.	Determining Range and Bearing	3–1
6.	Emergency Operation	3–4
7.	Other Operating Controls	3–4
8.	Use of Resonance Chamber	3–5
9.	Calibrating the Accessory Control Unit	3–6
10.	Notes on Operation	3–6

SECTION IV. THEORY OF OPERATION

1.	Distribution of Power	4–1
2.	Motor-Alternator	4–1
3.	Motor-Alternator Control Unit	4–1
4.	Modulator	4–3
5.	Transmitter	4–5
a.	General	4–5
b.	Pulse Transformer	4–5
c.	Pulse Modulation	4–5
d.	Operation of the R.F. System	4–5
e.	Theory of the R.F. System	4–7
6.	Receiver	4–7
a.	General	4–7
b.	Local Oscillator	4–8
c.	Automatic Frequency Control Circuit	4–8
d.	Input Circuits and Crystal Mixers	4–12
e.	Intermediate-Frequency Amplifier	4–13
f.	Demodulator and Video–Limiter	4–13
7.	Indicator	4–13
a.	General	4–13
b.	Square-Wave Multivibrator	4–14
c.	Video Amplifier	4–15
d.	Sweep Generator and Amplifier	4–16
e.	Marker Oscillator	4–17
f.	Marker Amplifiers and Sharpeners	4–18
g.	PPI Tube	4–18
h.	Power Supplies	4–18
8.	Rectifier Power Unit	4–18
a.	General	4–18
b.	300-Volt Regulator	4–20
c.	Auxiliary Rectifier	4–21

TABLE OF CONTENTS (Continued)

Paragraph		Page
9.	Accessory Control Unit	4-21
a.	General	4-21
b.	Linear Saw-Tooth Generator and Pickoff Diode	4-21
c.	Trigger Amplifiers and Blocking (Mark) Oscillator	4-22
d.	Power Supply	4-24
10.	Resonance Chamber	4-24
11.	Antenna Assembly and Bearing Control Unit	4-24
a.	Drive Mechanism	4-24
b.	R.F. System	4-25
c.	Synchro System	4-25
12.	Junction Box	4-29
	SECTION V. MAINTENANCE	
1.	Preventive Maintenance	5-1
2.	Locating Trouble	5-1
a.	Quick Check-up After Equipment Failure	5-1
b.	Locating Faulty Units	5-1
c.	Locating Faulty Components	5-3
3.	Maintenance Instructions (By units)	5-4
a.	Motor-Alternator	5-4
b.	Motor-Alternator Control Unit	5-4
c.	Modulator Unit	5-4
d.	Transmitter-Receiver	5-4
e.	Rectifier Power Unit	5-13
f.	Junction Box	5-17
g.	Plan Position Indicator	5-17
h.	Accessory Control Unit	5-21
i.	Antenna Assembly	5-21
j.	Resonance Chamber	5-27
k.	Miscellaneous	5-27

LIST OF TABLES

SECTION I. DESCRIPTION

Number		Page
1-1	Quick Reference Data	1-1
1-2	Equipment Supplied.	1-2
1-3	Equipment Required But Not Supplied	1-2
	SECTION II. INSTALLATION	
2-1	Assembly Procedure for Coaxial Cable Connector Modulator End of Pulse Cable	2-5
2-2	Assembly Procedure for Coaxial Cable Connector Transmitter End of Pulse Cable	2-6
2-3	Assembly Procedure for Coaxial Cable Connector Modulator End of IFF and Trigger Cables	2-7
2-4	Assembly Procedure for Coaxial Cable Connector Echo Box End of Echo Box Cable	2-8
	SECTION III. OPERATION	
3-1	List of Controls and Adjustments	3-7
	SECTION IV. MAINTENANCE	
5-0	Symptoms of Fuse Failure	5-0
5-1	Routine Maintenance Schedule	5-2
5-2	Fuse Locations	5-30
5-3	Voltage Measurements: Rectifier Power Unit	5-31
5-4	Voltage Measurements: Radar Receiver	5-32
5-5	Voltage Measurements: Plan Position Indicator	5-33
5-6	Voltage Measurements: Accessory Control Unit	5-34
5-7	Test Point Locations	5-35

LIST OF PHOTOGRAPHS AND DRAWINGS

SECTION I. DESCRIPTION

Figure	*Title*	*Page*
1-1	Units of Model SO-4 Equipment	1-0
1-2	Functional Block Diagram	1-4
1-3	Antenna Assembly	1-5
1-4	Motor-Alternator	1-6
1-5	Motor-Alternator Control Unit	1-6
1-6	Modulator Unit	1-6
1-7	Transmitter-Receiver	1-6
1-8	Indicator Unit	1-7
1-9	Accessory Control Unit	1-7
1-10	Resonance Chamber	1-7
1-11	Rectifier Power Unit	1-7
1-12	Junction Box	1-8
1-13	Bearing Control Unit	1-8

SECTION II. INSTALLATION

2-1	Lug Protected by Spaghetti	2-2

SECTION III. OPERATION

3-1	Accessory Control and Indicator Units: control panels	3-2
3-2	Signals on PPI Screen (20-mile range)	3-3
3-3	Signals and Range Marks on PPI Screen (80-mile range)	3-3
3-4	Resonance Chamber Signals	3-5

SECTION IV. THEORY OF OPERATION

4-1	Pulse-Forming Circuits (schematic)	4-2
4-2	Modulator Action	4-3
4-3	Waveform of Charging Voltage	4-4
4-4	Low-Frequency Analogy of R.F. System (schematic)	4-6
4-5	Pulse Transformer and Magnetron (schematic)	4-6
4-6	Receiver Unit: top view with cover removed	4-8
4-7	Functional Operation of Receiver A.F.C. Circuit	4-9
4-8	884 Plate Voltage with Transmitter Off	4-10
4-9	723A Repeller Voltage with Shifting Magnetron Frequency	4-10
4-10	Search Control Tube and Local Oscillator (schematic)	4-12
4-11	Plan Position Indicator: square-wave multivibrator (schematic)	4-14
4-12	Plan Position Indicator: video amplifier (schematic)	4-15
4-13	Plan Position Indicator: sweep generator and amplifier (schematic)	4-16
4-14	Plan Position Indicator: marker oscillator (schematic)	4-17
4-15	Plan Position Indicator: marker amplifiers and sharpeners (schematic)	4-17
4-16	Plan Position Indicator: ppi assembly (schematic)	4-19
4-17	Plan Position Indicator: ppi assembly	4-19
4-18	Plan Position Indicator: 7-kv. power supply (schematic)	4-20
4-19	Accessory Control Unit: linear saw-tooth generator and pickoff diode (schematic)	4-21
4-20	Accessory Control Unit: trigger amplifiers and blocking oscillator (schematic)	4-23
4-21	Accessory Control Unit: resonance chamber tuning amplifier (schematic)	4-23
4-22	Vertical Antenna Pattern	4-26
4-23	Horizontal Antenna Pattern	4-27
4-24	Synchro Block Diagram	4-28

LIST OF PHOTOGRAPHS AND DRAWINGS *(Continued)*

SECTION V. MAINTENANCE

Figure	*Title*	*Page*
5-1	Motor-Alternator Unit	5-5
5-2	Modulator Unit	5-5
5-3	Transmitter-Receiver Unit: interior with pulse transformer assembly hinged back	5-6
5-4	Receiver Chassis: cover removed, showing r.f. input assembly	5-8
5-5	Replacement of Local Oscillator	5-9
5-6	Receiver Input Assembly	5-10
5-7	Receiver Unit: top view with cover removed	5-11
5-8	Effect of Tune Control on Local Oscillator Output	5-12
5-9	Transmitter-Receiver Unit: cover removed	5-13
5-10	Transmitter-Receiver Unit: access doors open	5-14
5-11	Receiver Unit: tuning adjustments	5-15
5-12	Rectifier Power Unit: terminal panel lowered	5-16
5-13	Rectifier Power Unit: fuse and resistor panel lowered	5-16
5-14	Rectifier Power Unit: entire chassis lowered	5-16
5-15	Plan Position Indicator: underside of chassis	5-18
5-16	Plan Position Indicator: top view of chassis	5-19
5-17	Replacement of PPI Tube	5-20
5-18	Accessory Control Unit: top rear view of chassis	5-22
5-19	Accessory Control Unit: underside of chassis	5-23
5-20	Antenna Pedestal and Gear Housing	5-24
5-21	Antenna Pedestal: synchro cams and micro-switches	5-25
5-22	Antenna Pedestal: drive motor and synchro	5-25
5-23	Bearing Control Unit: details	5-26
5-24	Resonance Chamber (cover removed)	5-28
5-25	Resonance Chamber (cover removed)	5-29

LIST OF MAIN SCHEMATICS

(Following Section V)

External Cabling
Cabling Chart
Primary Power Breakdown, Power Source
Primary Power Breakdown, Power Flow
Synchro System
Servicing Block Diagram
Accessory Control Unit
Antenna Assembly
Bearing Control Unit
Indicator
Synchro System Block Diagram
Junction Box
Line Filter
Resonance Chamber
Modulator
Motor-Alternator, Control Unit, and Push Button Stations
Rectifier Power Unit
Receiver
Transmitter-Receiver
Outline and Dimension Drawings

GUARANTEE

The equipment including all parts and spare parts, except vacuum tubes, batteries, rubber and material normally consumed in operation, is guaranteed for a period of one year from the date of delivery of the equipment to and acceptance by the Government with the understanding that all such items found to be defective as to material, workmanship or manufacture will be repaired or replaced, f.o.b. any point within the continental limits of the United States designated by the Government, without delay and at no expense to the Government; provided that such guarantee will not obligate the Contractor to make repair or replacement of any such defective items unless the defect appears within the aforementioned period and the Contractor is notified thereof in writing within a reasonable time and the defect is not the result of normal expected shelf life deterioration.

To the extent the equipment, including all parts and spare parts, as defined above, is of the Contractor's design or is of a design selected by the Contractor, it is also guaranteed, subject to the foregoing conditions, against defects in design with the understanding that if ten per cent (10%) or more of any such said item, but not less than two of any such item, of the total quantity comprising such item furnished under the contract, are found to be defective as to design, such item will be conclusively presumed to be of defective design and subject to one hundred per cent (100%) correction or replacement by a suitably redesigned item.

All such defective items will be subject to ultimate return to the Contractor. In view of the fact that normal activities of the Naval Service may result in the use of equipment in such remote portions of the world or under such conditions as to preclude the return of the defective items for repair or replacement without jeopardizing the integrity of Naval communications, the exigencies of the Service, therefore, may necessitate expeditious repair of such items in order to prevent extended interruption of communications. In such cases the return of the defective items for examination by the Contractor prior to repair or replacement will not be mandatory. The report of a responsible authority, including details of the conditions surrounding the failure, will be acceptable as a basis for effecting expeditious adjustment under the provisions of this contractual guarantee.

The above one year period will not include any portion of time the equipment fails to perform satisfactorily due to any such defects, and any items repaired or replaced by the Contractor will be guaranteed anew under this provision.

REPORT OF FAILURE

Report of failure of any part of this equipment, during its service life, shall be made to the Bureau of Ships in accordance with current instructions. The report shall cover all details of the failure and give the date of installation of the equipment. For procedure in reporting failures see Chapter 67 of the "Bureau of Ships Manual," or superseding instructions.

REPLACEMENT MATERIAL

To expedite the procurement of replacement parts, all requests or requisitions for replacement material should include complete descriptive data covering the part desired, in the following form:

1. Name of part desired.
2. Federal Stock number (if assigned).
3. Navy Type number (if assigned) including *prefix* and *suffix* as applicable.
4. Commercial designation.
5. Model designation (including *suffix*) of equipment in which used.
6. Navy Type designation (including *prefix* and *suffix* where applicable) of major unit in which part is used.
7. Contract, purchase order, requisition, etc. under which the equipment was procured.
8. Circuit symbol designation of part.
9. (*a*) Navy drawing and/or specification number. (Include part or group number.)
   (*b*) Manufacturer's drawing or specification's number. (Include part or group number.)
10. Rating or other descriptive data.

INSTALLATION RECORD

The blank spaces indicated below should be filled in by Navy personnel immediately upon completion of the initial installation.

Contract Number: NXsr-39240 Date of Contract: November 2, 1943

Serial Number of equipment_____

Date of acceptance by the Navy_____

Date of delivery to contract destination_____

Date of completion of installation_____

Date placed in service_____

DANGER — High Voltages

OPERATION OF THIS EQUIPMENT INVOLVES THE USE OF HIGH VOLTAGES (15,000 VOLTS) WHICH ARE DANGEROUS TO LIFE. OPERATING PERSONNEL MUST AT ALL TIMES OBSERVE ALL SAFETY REGULATIONS. DO NOT CHANGE TUBES OR MAKE ADJUSTMENTS INSIDE EQUIPMENT WITH HIGH VOLTAGE SUPPLY ON. DO NOT DEPEND UPON INTERLOCKS OR DOOR SWITCHES FOR PROTECTION BUT ALWAYS SHUT DOWN MOTOR GENERATORS OR OTHER POWER EQUIPMENT. NOTE THAT BATTLE SWITCHES, WHEN ON, SHORT CIRCUIT THE INTERLOCKS, REMOVING ALL PROTECTION. UNDER CERTAIN CONDITIONS DANGEROUS POTENTIALS MAY EXIST IN CIRCUITS WITH POWER CONTROLS IN THE OFF POSITION DUE TO CHARGES RETAINED BY CAPACITORS, ETC. TO AVOID CASUALTIES ALWAYS REMOVE POWER, DISCHARGE AND GROUND CIRCUITS PRIOR TO TOUCHING THEM.

Since the use of high voltages (15,000 volts) which are dangerous to human life is necessary to the successful operation of the equipment covered by these instructions, certain reasonable precautionary measures must be carefully observed by operating personnel during the adjustment and operation of the equipment.

The major portions of the equipment are within shielding enclosures, protected at normal access points with safety interlock switches which act to shut off dangerous voltages within the enclosures when the latter are opened.

It should be borne in mind that interlocks are provided only on normal entrances, and therefore the removal of side, back, or top screens or of commutator covers will not cause interlocks to function and will thereby allow access to circuits carrying voltages dangerous to human life.

While every practicable safety precaution has been incorporated in this equipment, the following rules must be strictly observed:

KEEP AWAY FROM LIVE CIRCUITS. Under no circumstances should any person other than authorized maintenance personnel be permitted to reach within or in any manner gain access to the enclosure with interlocks or battle switches closed or with power supply line switches to the equipment closed; or to approach or handle any portion of the equipment which is supplied with power, or to connect any apparatus external to the enclosure to circuits within the equipment or to apply voltages to the equipment for testing purposes while any noninterlocked portion of the shielding or enclosure is removed or open. Wherever feasible in testing circuits, maintenance personnel should check for continuity and resistance rather than directly checking voltage at various points.

DON'T SERVICE OR ADJUST ALONE. Under no circumstances should any person reach within or enter the enclosure for the purpose of servicing or adjusting the equipment without the immediate presence or assistance of another person capable of rendering aid.

DON'T TAMPER WITH INTERLOCKS. Under no circumstances should any safety interlock switch be removed, short circuited, or tampered with in any way, by other than authorized maintenance personnel, nor should reliance be placed upon the interlock switches for removing voltages from the equipment.

THE ATTENTION OF OFFICERS AND OPERATING PERSONNEL IS DIRECTED TO CHAPTER 67 OF BUREAU OF SHIPS MANUAL OR SUPERSEDING INSTRUCTIONS ON THE SUBJECT OF RADIO-SAFETY PRECAUTIONS TO BE OBSERVED.

AN APPROVED POSTER ILLUSTRATING THE RULES FOR RESUSCITATION BY THE PRONE PRESSURE METHOD SHALL BE PROMINENTLY DISPLAYED IN EACH RADAR ENCLOSURE. POSTERS MAY BE OBTAINED UPON REQUEST TO THE BUREAU OF MEDICINE AND SURGERY.

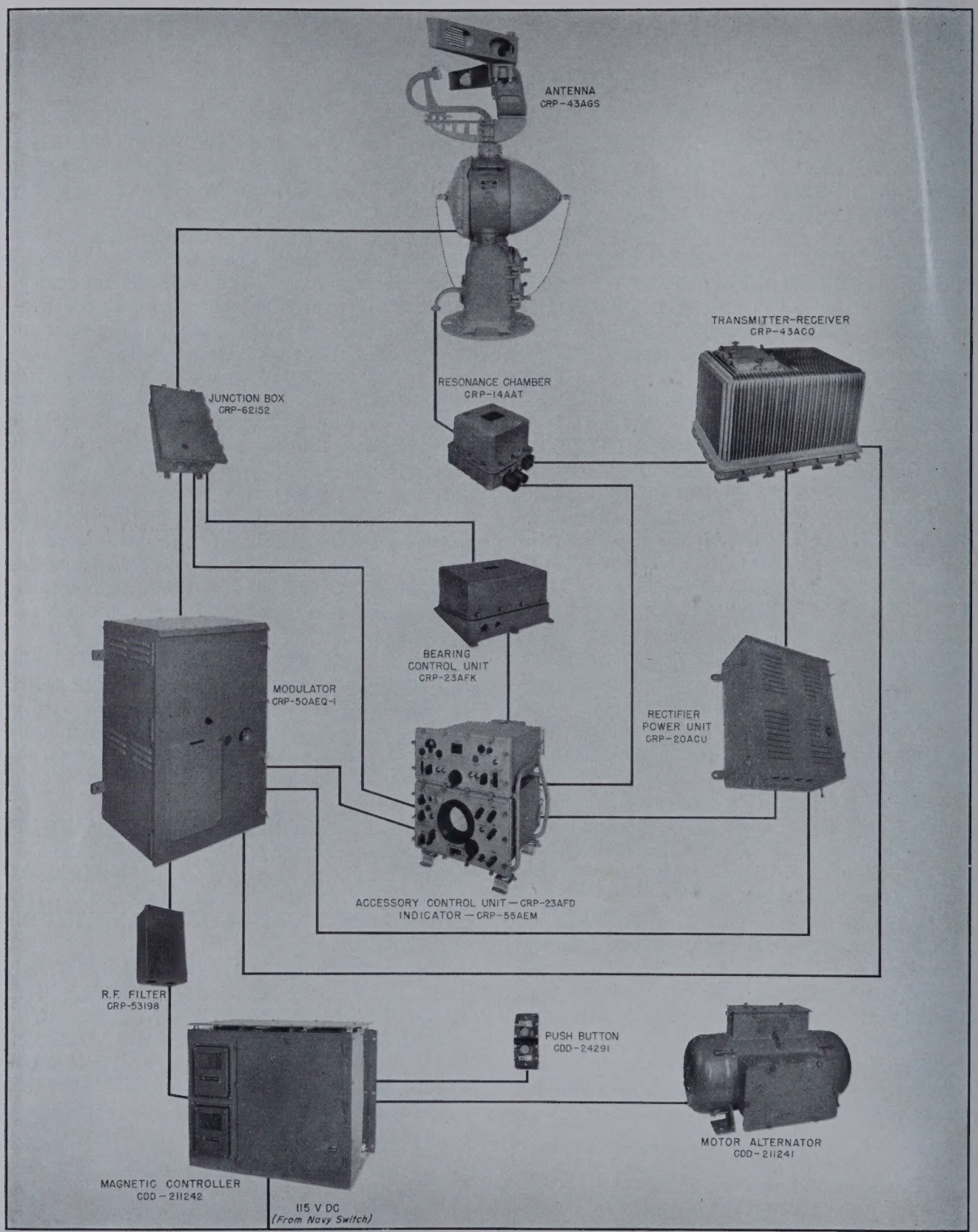


Figure 1-1—Units of Model SO-4 Equipment

SECTION 1. DESCRIPTION

TABLE 1-1. — QUICK REFERENCE DATA

Name and designation of equipment	Navy Model SO-4 Radar Bearing Control Unit CRP-23AFK (supplied on separate contract)
Contract number and date	NXsr 39240 Nov. 2, 1943 (Model SO-4 Radar) NXsr 39226 Nov. 6, 1943 (Bearing Control Unit)
Contractor	Raytheon Manufacturing Company
Cognizant Naval Inspector	Inspector of Naval Material, Boston, Mass.
Frequency band	X-band
Frequency control (type)	Self-excited oscillator
Type of emission	Pulse
Peak power output	Approximately 50 kw.
Power supply characteristics (approx. values)	*Line voltage:* 105 to 130 (117 d.c.) *Normal current:* 15.5 to 12.5 (14 amps.) *Starting current:* 70 amps. (average) *Standby current:* 14.2 to 11.2 amps. *Maximum operating current:* 15.5 amps. with 105-volt line input and with full load on system
Number of packages (complete shipment)	Eleven
Total cubical contents, installed and packed for shipment	127.4 cu. ft.
Total weight, installed and packed for shipment	2568 lbs.

Vacuum Tube Complement

Quantity	*Tube Type*	*Quantity*	*Tube Type*
11	6SN7-GT	1	2J49
10	6AC7	1	1B24
6	5U4-G	1	724-A
2	6SJ7-GT	1	723-A
2	OC3 (VR105)	2	6H6
		1	807
2	38205 (VR105-30)	4	3B24
		1	5FP7
1	OD3 (VR150-30)	1	6AG7
		1	6-4
2	6B4-G	1	6X5-GT
1	2050	1	4C35
1	884	1	RKR-72

TABLE 1-2. — EQUIPMENT SUPPLIED

Quantity	Number Series	Name of Unit	Navy Type Designation	Over-all Dimensions (Ins.) A: Crated B: Uncrated Width	Height	Depth	Volume (Cu. Ft.) A: Crated B: Uncrated	Weight (Lbs.) A: Crated B: Uncrated
1	501—599	Antenna Assembly	CRP-66AGS	A: 35 B: 48	37 52 (Diameter)	57	A: 44 B: 59.2	A: 405 B: 160
1	701—799	Accessory Control Unit	CRP-23AFD	A: 29	23	27	A: 10.4	A: 225
1	401—499	Indicator Unit	CRP-55AEM	B: 21	25	22	B: 6.7	B: 145
1		Mounting Rack	CRP-10252					
		Note: These two units are supplied mounted in rack.						
1	1401—1499	Bearing Control Unit	CRP-23AFK	A: 29 B: 18	25 10	14 19	A: 5.9 B: 2.0	A: 100 B: 55
1	1301—1399	Junction Box	CRP-62152	A: 20 B: 17	23 15	12 8	A: 3.2 B: 1.2	A: 82 B: 45
1	2001—2099	Motor-Alternator Control Unit	CDD-211242	A: 31 B: 31	23 26	36 16	A: 14.9 B: 7.5	A: 400 B: 235
1	2001–2099	Motor-Alternator	CDD-211241	A: 31 B: 25	22 16	20 17	A: 7.9 B: 3.9	A: 370 B: 280
1	101—199	Modulator	CRP-50AEQ-1	A: 36 B: 24	31 31	23 17	A: 14.9 B: 7.3	A: 380 B: 285
1	201—299	Rectifier Power Unit	CRP-20ACU	A: 32 B: 23	27 25	24 14	A: 12 B: 4.6	A: 245 B: 148
1	301—399	Transmitter-Receiver	CRP-43ACN* CRP-43ACO	A: 31 B: 24	27 19	27 18	A: 13.1 B: 4.75	A: 232 B: 134
1	3001—3099	Radar Receiver (Mounted inside Transmitter-Receiver)	CRP-46ADAP* CRP-46ADA					
1	601—699	Resonance Chamber	CRP-14AAT	A: 29 B: 10	19 10	17 8	A: 5.5 B: 0.5	A: 129 B: 20
		RF Filter Assembly	CRP-53198	B: 11	6	5	B: 0.2	B: 25
		Push Button Station	CDD-24291	B: 4	4	8	B: 0.07	B: 3
		NOTE: These three units are shipped in one *case.*						
60 ft.		Waveguide (RG-51/U)		A: 149	3	6	A: 1.5	A: 100

* No access door.

TABLE 1-3. — EQUIPMENT REQUIRED BUT NOT SUPPLIED

Quantity	Name of Unit	Navy Type Designation	Required Characteristics
1	Line Switch (Murdock Electric Manufacturing Co.)	Spec. KE 17-S-18	60 amps. DPST Fused (Marked: "Radar Line Switch 40-amp. Fuse") $4\frac{7}{16}$" x $13\frac{3}{16}$" x $3\frac{5}{16}$" Weight, 11 lbs. Enclosed, drip-proof.

1. GENERAL.

Navy Model SO-4 Radar is a medium-power surface-scanning equipment designed for installation on vessels having a 115-volt d.c. power supply.

Targets on or near the surface of the water are presented on the screen of a Plan Position Indicator.

The equipment, while similar to Model SO-1 and SO-8 Radars, differs from these in certain respects. The chief differences are in the Transmitter-Receiver, Antenna, and Resonance Chamber which operate in the X-band rather than in the S-band. The Receiver includes an automatic frequency control (a.f.c.) circuit for the local oscillator. The Resonance Chamber (Echo Box) is motor-tuned by remote control.

In addition, the Rectifier Power Unit (R.P.U.), which supplies power to the Receiver, has been elaborated to improve its voltage regulation. Included in the R.P.U. is part of the power supply for the Indicator Unit, which in other SO-Series Radars powered from a 400-cycle source was located in that unit. Since the SO-4 is a 60-cycle system, transformers and other circuit components are necessarily larger than for 400-cycle systems and cannot be housed within the Indicator.

A marine-type Motor-Alternator is used to convert the 115-volt d.c. ship's power to 60-cycle power at the same voltage. This is a departure from the 400-cycle alternator used in previous SO-Series equipments. The 60-cycle power operates the Modulator, Transmitter-Receiver, Plan Position Indicator, Rectifier Power Unit, synchro system, Accessory Control Unit, and Bearing Control Unit. The resonance chamber tuning motor is supplied from the Rectifier Power Unit. The antenna drive motor is operated directly from the ship's supply. Sufficient additional 60-cycle power is provided to operate a type BN IFF Unit.

The modulator action is supplied from a line-type soft-tube pulser employing a d.c. resonant charging system in conjunction with a hydrogen thyratron tube. The thyratron may be considered as a high-speed electronic switch replacing the rotary spark gap previously used. Maintenance is considerably simplified, since the mechanical maintenance required on spark gaps is eliminated.

An Accessory Control Unit is included to provide a direct-reading range dial and the additional controls required for X-band operation.

A Bearing Control Unit is available to provide true-bearing indication.

2. BASIC PRINCIPLES OF OPERATION.

a. GENERAL. — Refer to the block diagram of functional operation, Fig. 1-2. The large blocks represent units of the equipment, and are interconnected by flow lines to show the basic action of the system. The subdivisions of these blocks represent principal circuits or assemblies within each unit and serve to identify the unit which generates or controls a circuit action.

b. POWER SOURCE. — A 3-h.p. compound motor operated from the ship's 115-volt d.c. power drives the Alternator which generates 60-cycle power at 115 volts. This potential is stepped up by a transformer and rectified by a full-wave rectifier. The pulse-forming line is charged through a charging choke and diode.

c. OSCILLATOR KEYING. — The pulse line and thyratron modulator convert the alternator output into a one-microsecond (square-wave) voltage across the primary of the pulse transformer. The repetition rate is roughly 465 pulses per second.

A low-amplitude sample of this pulse is delivered to the Indicator to trigger (synchronize with the transmitted pulse) the radial sweep, the range marks oscillator, the PPI unblanking circuit, and the Accessory Control Unit.

The pulse transformer, located in the Transmitter-Receiver Unit, passes the main pulse waveform and increases its amplitude to approximately 12 kv.

These one-microsecond pulses are applied to the magnetron oscillator at a power input of approximately 125 kw. When power is applied, microwave energy is generated by the oscillator and radiated directly into a pre-tuned r.f. system.

d. R.F. RADIATION. — The r.f. output is conducted to the Antenna through a rectangular waveguide (transmission line) and radiated onto the surface of a reflector. The reflector (a paraboloidal section) concentrates and re-radiates the energy in a narrow beam. The pattern is about 2° in the horizontal and 14° in the vertical plane. As the Antenna rotates (at approximately 6 r.p.m.) the beam sweeps over the surrounding surface area.

e. RECEPTION OF ECHOES.—When the transmitted signal strikes a target, a small part of the energy is reflected back to the Antenna Assembly. The Antenna returns a part of this energy to the Receiver via the waveguide and TR box (duplexing cavity) located in the Transmitter-Receiver Unit. The TR box acts as an automatic electronic switch

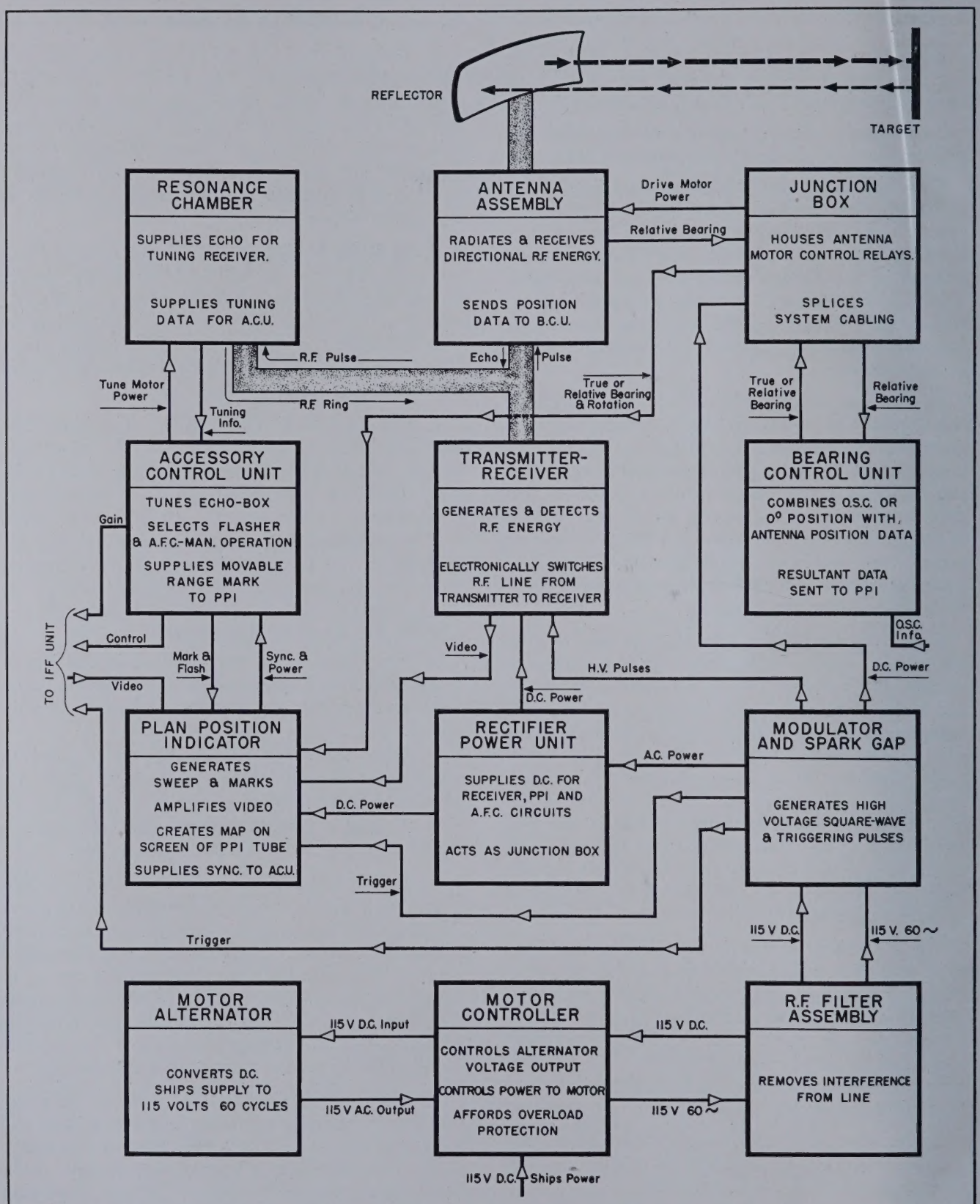


Figure 1-2—Functional Block Diagram

connecting the Receiver to the waveguide while the Transmitter is off and isolating the Receiver from the waveguide while the Transmitter is on. An ATR (anti-TR) box, located nearer the magnetron, presents a high impedance to the reflected echo, thus preventing dissipation of echo energy at the magnetron.

The echo is amplified and detected in the Receiver, which is of the superheterodyne type, and delivered to the Indicator as a rectified video signal. Here the video signal is amplified and applied to the PPI tube, finally appearing on the tube screen as a small bright arc or spot.

f. DETERMINATION OF BEARING. — The radial sweep of the PPI tube moves outward from the center of the tube in synchronism with the transmitted signal. The trace is made to rotate around the center of the tube in unison with the rotation of the Antenna on the mast. Thus the angular position of the sweep always corresponds with that of the Antenna. (In true-bearing operation, the PPI sweep position corresponds to the compass position of the Antenna.)

g. DETERMINATION OF RANGE. — Because of this synchronism between signal and sweep, the distance of the target trace from the center of the screen is directly proportional to the distance of the target from the Transmitter. Target range can therefore be estimated by noting the position of the target trace on the PPI tube with reference to the PPI range marks. The range of targets falling between these fixed range marks can be read from the Accessory Control Unit. This is done by rotating the hand-crank on the A.C.U. until the movable range mark appearing on the PPI tube coincides with the signal to be ranged. Range is then read directly from the A.C.U. dial.

h. OPERATION OF SYNCHRO SYSTEM. — Rotation of the Antenna is initiated by a 115-volt d.c. motor energized directly from the ship's supply. Mechanically coupled to the Antenna is a synchro generator which delivers bearing information to the stator winding of an intermediate synchro located in the Bearing Control Unit. The rotor of this intermediate synchro is geared to a step motor which follows the ship's gyro compass. The synchro, functioning as a differential coupling transformer, combines antenna relative-bearing information and compass information and produces in its rotor winding a resultant output voltage which represents true bearing. This voltage drives the rotating sweep coil of the PPI, always keeping the sweep properly positioned to provide true-bearing indications of received signals.

To permit the reading of relative bearing when the system is operating on true bearing, a ship heading flasher is provided. This circuit produces a momentary intensification of the radial sweep at the bearing corresponding to the ship's heading. Relative bearing is read by noting the angle existing between the flash and the target trace.

i. RANGE OF EQUIPMENT. — The range of the equipment depends primarily upon the location, size and character of the target, and to a lesser degree upon existing weather conditions. Under average conditions the equipment is capable of locating targets of fair size as far as the optical horizon, as seen from the antenna location.

j. TUNING BY RESONANCE CHAMBER. — In the absence of actual targets, the Receiver is tuned by the use of the Resonance Chamber (Echo Box). (See Fig. 1-10.)

3. LIST OF INCLUDED UNITS.

Model SO-4 Radar Equipment consists of the following separate units:

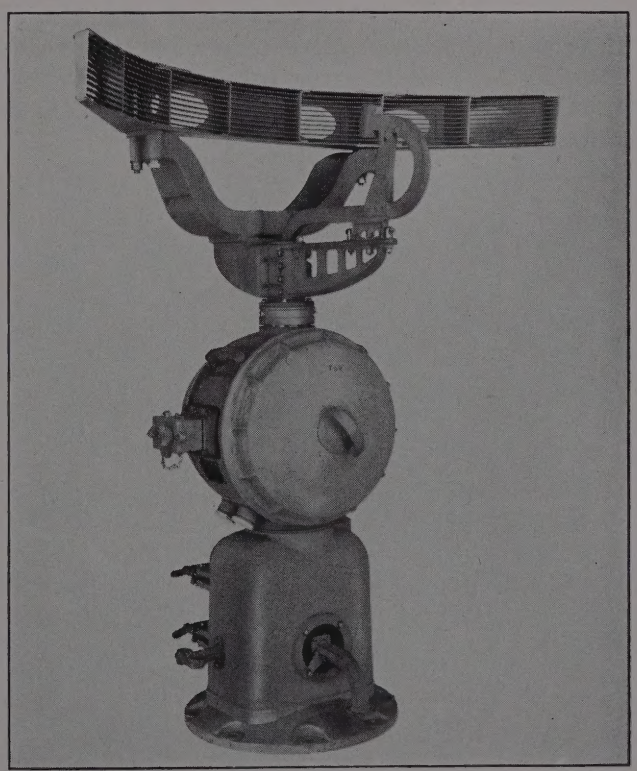


Figure 1-3—Antenna Assembly

a. THE ANTENNA ASSEMBLY comprises: (1) a drive mechanism including a drive motor and gear train; (2) a synchro system including a synchro generator and gear train enclosed in a watertight streamlined housing; (3) a rotating radiating system consisting of a goose-neck nozzle and a slatted reflector (a paraboloidal section), and r.f. fittings for coupling the rotating radiating system to the stationary waveguide; and (4) a supporting pedestal and base plate.

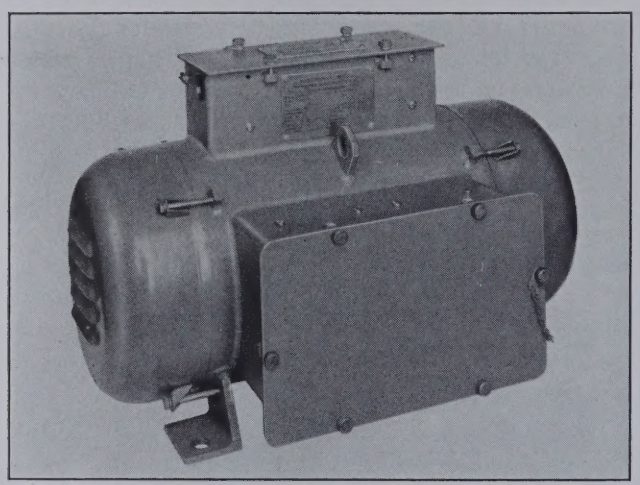


Figure 1-4—Motor-Alternator

b. THE MOTOR-ALTERNATOR comprises a 115-volt d.c. 3.5-h.p. drive motor and a 115-volt 60-cycle 2-kw. Alternator to convert the ship's power to a.c. voltage supplying the component units in the system.

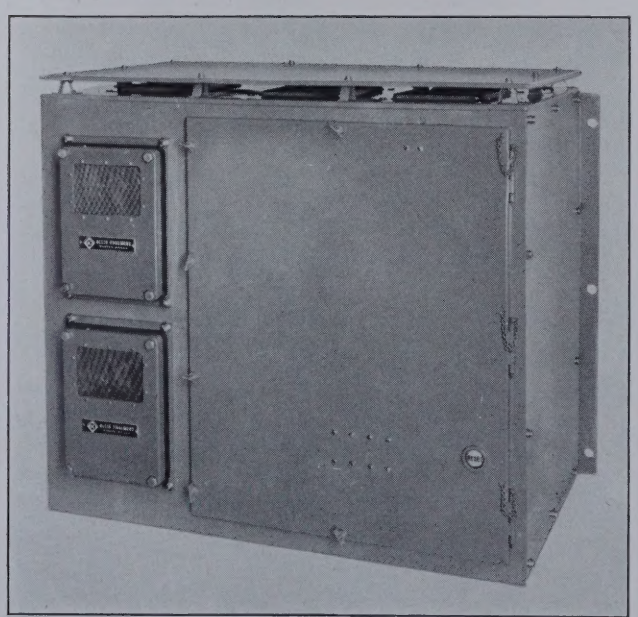


Figure 1-5—Motor-Alternator Control Unit

c. THE MOTOR-ALTERNATOR CONTROL UNIT is provided for starting the motor in conjunction with a pair of Start-Stop Push Button Switches, one located near the Plan Position Indicator and the other near the Motor-Alternator Control Unit. Included in the unit are speed and voltage regulating circuits.

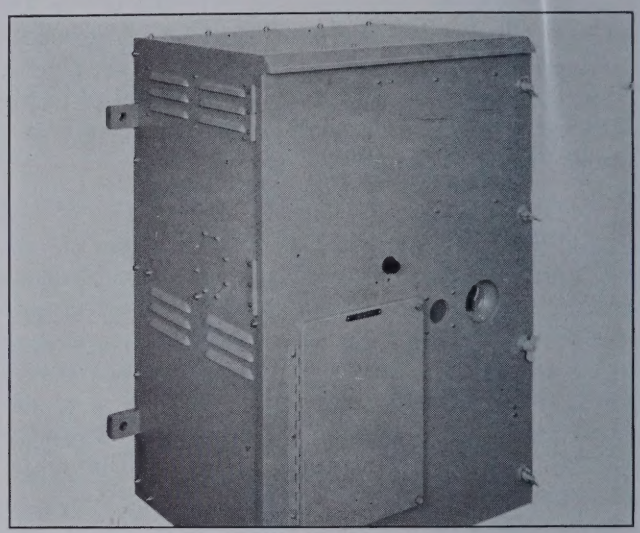


Figure 1-6—Modulator Unit

d. THE MODULATOR includes a charging transformer and rectifier, a pulse-forming line, and a voltage-dividing network in the pulse line output to satisfy the triggering voltage requirements.

The electronic keying circuits consist of a blocking oscillator, cathode follower, and hydrogen thyratron keying tube, plus their d.c. power supply. These are used to key the Transmitter approximately 465 times per second.

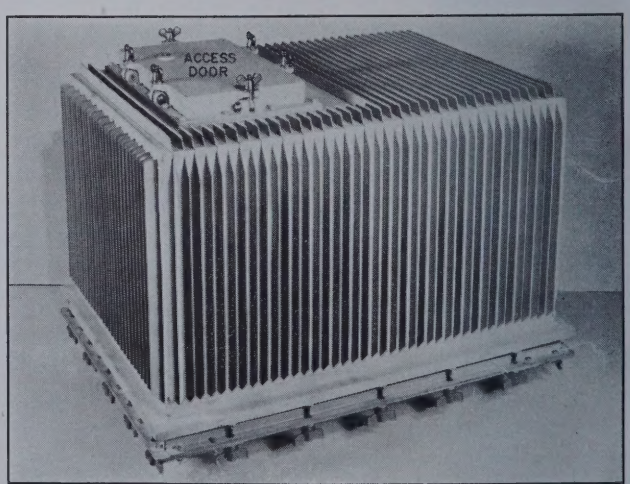


Figure 1-7—Transmitter-Receiver

e. THE TRANSMITTER-RECEIVER. — The Transmitter comprises a high-voltage pulse transformer, a magnetron oscillator, and an r.f. system including a TR and an anti-TR box.

The Receiver is a compact superheterodyne type which includes an automatic frequency control circuit.

A blower motor is included for cooling both the magnetron and the Receiver.

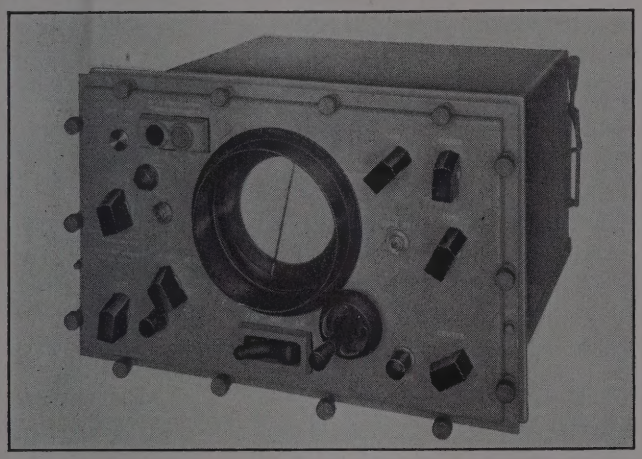


Figure 1-8—Indicator Unit

f. THE PLAN POSITION INDICATOR is the display unit of the system. It houses a PPI tube with the deflection coil drive mechanism and bearing dial, and the video, marks, and sweep circuits. The unit also contains the chief operating controls.

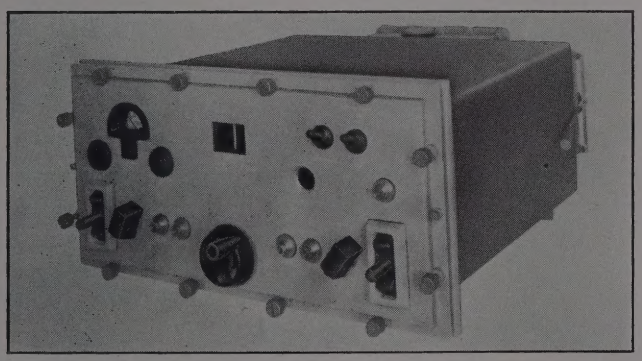


Figure 1-9—Accessory Control Unit

g. THE ACCESSORY CONTROL UNIT (A.C.U.) provides a movable mark on the PPI tube for reading ranges falling between the fixed PPI range marks. Range is directly indicated on a dial coupled to a hand-crank controlling the location of the movable mark. Also provided are a key switch and gain control for operating external IFF equipment, an a.c. line voltmeter, a switch for changing from manual to automatic receiver tuning, and controls for remotely tuning the Resonance Chamber.

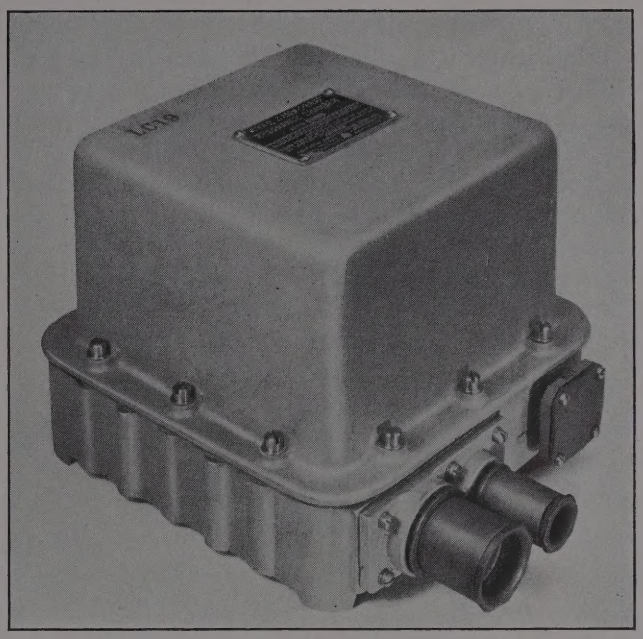


Figure 1-10—Resonance Chamber

h. THE RESONANCE CHAMBER (ECHO BOX) provides a high-Q circuit producing an artificial echo on the PPI tube for tuning the Receiver in the absence of actual targets. It is motor-tuned by remote control at the A.C.U., and it contains a crystal detector to supply remote tuning information.

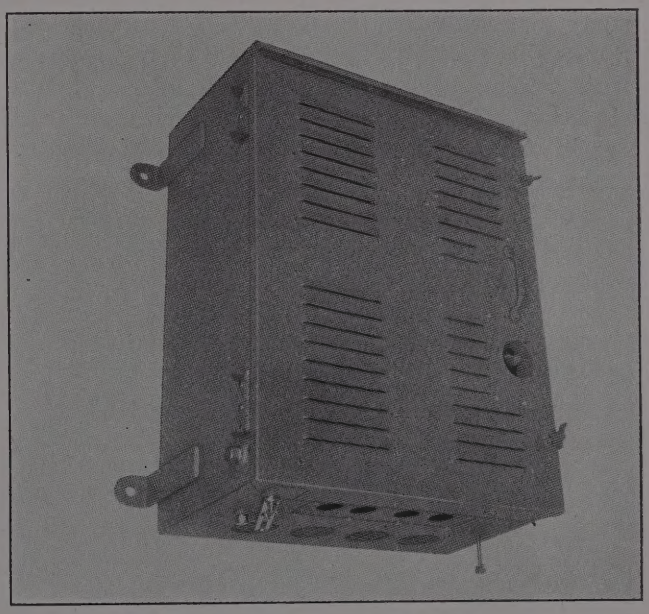


Figure 1-11—Rectifier Power Unit

i. THE RECTIFIER POWER UNIT contains regulated and unregulated power supplies for the Receiver and Indicator. A time-delay relay K-202

controls the 24-volt d.c. selenium rectifier circuit which in turn supplies high-voltage keying relay K-201. An automatic time delay of three minutes is thus provided between starting and high power application of the modulator. The time delay circuit does not drop out completely for instantaneous power failures. The selenium rectifier also supplies the resonance chamber tuning motor.

Blown-fuse indicators are included with several fuses to show their condition. The unit also serves as a junction box for cable connections.

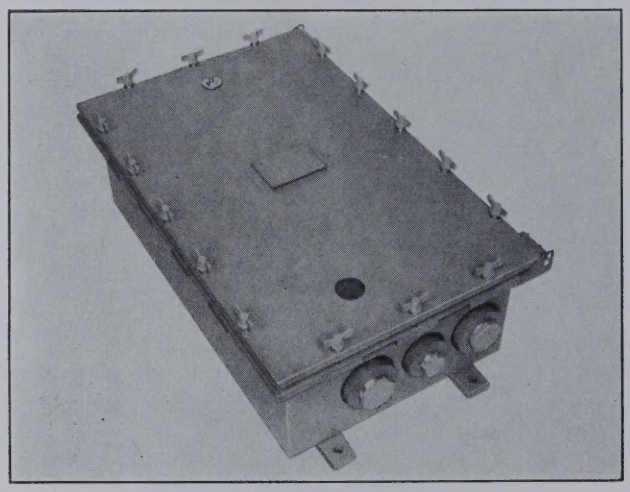


Figure 1-12—Junction Box

j. THE JUNCTION BOX contains terminal strips interconnected internally to serve as tying-in points between the Indicator, Bearing Control Unit, Modulator, and Antenna Assembly. Also included is a relay supplied from the selenium rectifier in the Rectifier Power Unit for reversing antenna rotation.

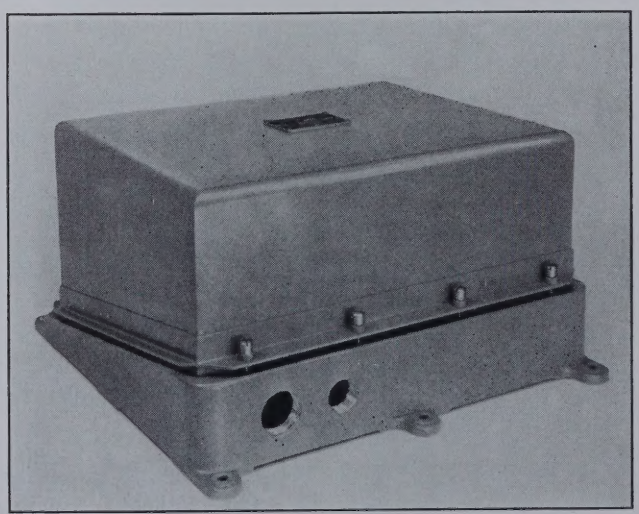


Figure 1-13—Bearing Control Unit

k. THE BEARING CONTROL UNIT (accessory item) contains a 5DG synchro used as a differential coupling transformer between the Antenna, ship's gyro compass, and the radial sweep deflection coil in the PPI assembly. Also included is a step motor driving the 5DG, a 1F synchro, with associated micro-switches S-1408 and S-1409; and a synchronizing relay K-401 is included to provide locking circuits to maintain the system in synchronization.

4. LOCATION OF COMPONENTS.

Although the equipment comprises a number of separate units, no trouble should be experienced in tracing circuits if the following classification of components is understood.

Each unit has been assigned its own identifying number series, and each component in a unit bears a number within the series. For example, the Transmitter has been assigned the 300 series, and thus any component bearing a number between 301 and 399 is identified as part of the Transmitter.

Unit	*Number Series*
Motor-Alternator	2001-2099
Motor-Alternator Control Unit	2001-2099
Modulator	101-199
Rectifier Power Unit (R.P.U.)	201-299
Transmitter	301-399
Plan Position Indicator	401-499
Antenna Assembly	501-599
Resonance Chamber	601-699
Accessory Control Unit	701-799
Junction Box	1301-1399
Bearing Control Unit	1401-1499
Radar Receiver	3101-3109

Each component in a unit is designated by a symbol composed of a letter (identifying its function) plus a number falling within a number series (identifying the unit containing it). Thus, B-301 is a motor in the Transmitter-Receiver Unit (the blower motor), and S-402 is a switch in the Indicator Unit (the Antenna Control Switch). Each symbol is stamped on the chassis near its component.

5. CABLING DESIGNATIONS.

The terminal numbers of all interconnecting cables are the same at both ends, with the exception of the cables receiving the alternator output. For example, referring to cabling schematic C-9K-7, cable V, MHFA-10, connects terminal strip E-202 in the Rectifier Power Unit to jack board J-401 in the Plan Position Indicator. The individual conductors connect to correspondingly numbered terminals at each end.

SECTION II. INSTALLATION

1. POWER REQUIREMENTS.

Model SO-4 Radar is designed to operate from a 115-volt d.c. source, and under normal operating conditions draws approximately 2.5 kw. The alternator field circuit is automatically regulated, and the 60-cycle alternator output remains at 115 volts ±5 volts. Frequency regulation is provided, holding the 60-cycle output to ±2 cycles.

2. INSTALLATION LAYOUT.

Standard layouts for the installation of Model SO-4 Radar on specified craft have been prepared by the Planning Departments of several Navy Yards. These plans are available at most installation bases, or may be obtained by writing to the Bureau of Ships. Consequently, no layouts are included with this text.

The Antenna Assembly, Junction Box, Resonance Chamber, and Transmitter-Receiver are watertight and may be mounted in exposed locations. The remaining units should be sheltered from the weather.

3. HOUSINGS AND SUPPORTS.

Housings and supports will be shown on the Navy Yard plans. Where plans are not available the following factors must be carefully considered before locating the unit:

a. Accessibility for adjustments and maintenance.
b. Operating convenience.
c. Ventilation.
d. Protection from weather.
e. Inter-unit cabling.
f. Interference with other equipment.
g. Short and direct runs for waveguide and coaxial cables.

4. INSTALLATION REQUIREMENTS.

The locations of units cannot be completely standardized as they vary with different types of craft. This applies especially to the Motor-Alternator, Motor-Alternator Control Unit, Modulator, and Rectifier Power Unit, as outlined later.

a. THE ANTENNA ASSEMBLY bolts to a plate fitted to the mast. A platform should be provided on the mast below the Antenna for servicing if possible. A safety ring may be used, however, if a platform is impracticable.

The waveguide should be clamped to the mast every few feet with lead-lined cleats. Information on fabricating waveguide will be found in the R.I.P.

Cable entrances to the Antenna should be made by means of standard terminal tubes. When these tubes are installed, the threads should be coated to prevent freezing-in, since they will have to be removed if it becomes necessary to replace the Antenna. Ordinary cup grease or anti-seize compound is suitable for this purpose. All terminal tubes must be made watertight.

All tubes and cables as well as the outside of the waveguide should be carefully chromated and painted after installation to prevent corrosion.

b. THE MOTOR-ALTERNATOR should be mounted with its axis of rotation fore and aft. If possible it should be at a deck level above the water line or at least at a deck level not lower than the main generators. Sufficient clearance should be provided above and in front of the unit for terminating the proper interconnecting cables at the alternator and for removing the bearing retainer plates for periodic lubrication.

c. THE MOTOR-ALTERNATOR CONTROL UNIT is designed for bulkhead mounting and should be located close to the Motor-Alternator. The bulkhead must be reinforced to keep the weight of the unit off the bulkhead sheathing. Clearance should be provided for opening the unit door when replacing fuses or servicing relay contacts.

d. THE MODULATOR should be located where danger from explosive fumes is at a minimum. The location will vary according to the type of craft. Provision should be made for accessibility, as frequent inspection is required. If bulkhead-mounted, the unit should be so positioned as to provide access for servicing.

e. THE TRANSMITTER-RECEIVER usually mounts at the base of the antenna mast and connects to the Antenna through a length of waveguide, which is shipped in standard lengths. The unit is preferably mounted in a sheltered location, however, where it can be serviced during bad weather.

Cable and waveguide entrances are from below. Two cables enter the terminal box located on the bottom of the unit and the third cable enters through a plug and jack on the bottom of the case itself. Since the unit is waterproof, all terminal

tubes (supplied by the installing yard) must be completely watertight and packed in accordance with standard Navy specifications. Sufficient cable slack should be left to provide for occasional repair of the cable ends. All cables should be protected so that they will not be used as grab rails. Where cables pass through the deck they should be protected by watertight kick pipes.

The pulse cable connecting the Modulator to the Transmitter is either an RG-14/U (armored) or an RMA-10A. Fifty feet of pulse cable are supplied with a special plug (for the transmitter end) already attached and filled with Dow-Corning #4 sealing compound. For connection to the Modulator, another special plug (supplied) must be attached at the time of installation, as shown on page 2-6. The cable should be as short and direct as practicable and must not be bent on less than an 8″ radius.

f. THE MAIN LINE SWITCH is not provided with the equipment and will be supplied by the Navy. The switch supplied should be checked to make sure that it is at least of 60-amp. capacity. It should preferably be flameproof, but a non-flameproof switch may be used if a warning is posted not to remove the switch cover without first cutting off the power at the distribution panel in the engine room. Both the Main Line Switch and the switch on the distribution panel should be properly labeled.

If the switch on the distribution panel is of the circuit-breaker type, it must be capable of withstanding a normal starting surge of over 100 amps.

The main power supply should always be fused with 60-amp. single-link fuses. (During starting these fuses may carry over 100 amps. for one or two seconds.)

g. THE PLAN POSITION INDICATOR is rack-mounted on a shelf or table in the chart house, usually on the port side. It should be readily accessible, and clearance must be allowed in front for removal of the unit from its case. Sufficient space must be left to give access to the terminal box at the rear. When the Indicator is mounted below the operator's eye level, the front feet should be raised about 2″ to improve visibility. Cable entrances are made at the rear with watertight terminal tubes.

h. THE ACCESSORY CONTROL UNIT is mounted above the Indicator in a special mounting rack which holds both units. The rack is provided with shock mounts. Clearances required are the same as for the Indicator.

The interconnecting cable between the two units is supplied, coiled up in the junction box of the unit. The interconnecting conduit is also supplied. Other cable entrances are made at the rear with watertight terminal tubes.

i. THE RESONANCE CHAMBER (Echo Box) should be bulkhead-mounted somewhere near the Transmitter and physically in series with the waveguide run. The rectified output voltage is fed to the A.C.U. through a coax cable. Sufficient cable slack should be left to make provision for occasional repair of the cable ends.

j. THE RECTIFIER POWER UNIT may be located wherever convenient, consistent with good ventilation and accessibility. The cables entering this unit should not be clamped so tightly to the bulkhead that the shock mounting cannot absorb shocks.

k. THE BEARING CONTROL UNIT (an accessory unit) is bulkhead-mounted, and cable entrances are made from the bottom. Adequate space must be provided to give access for maintenance. The cover is removed by lifting outward and up.

l. PROTECTION OF EXPOSED UNITS. — All tubes and cables as well as the outside of the waveguide should be carefully chromated and painted after installation to prevent corrosion. *The Plexiglas cover on the antenna nozzle must not be painted.*

5. CABLING AND CONNECTIONS.

a. GENERAL INSTRUCTIONS. — Refer to the external cabling diagram and carefully follow all specifications as to cable type.

Use standard Navy armored cable for all interunit connections, except the pulse cable (No. XIV). Run all cables in accordance with standard marine wiring practice. Allow an extra foot or two at terminations to permit the removal of units for servicing and the repair of the cables themselves.

Lug and number all individual conductors. *When crimped-type lugs are used they should be soldered as well as crimped.*

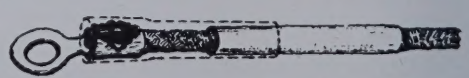


Figure 2-1—Lug Protected by Spaghetti

Take care to prevent short circuits at terminal strips and jack and plug assemblies. Remove insulation from conductors only far enough to make good soldered connections, and avoid dropping solder and wire clippings between terminals. Place

a short piece of spaghetti tubing or insulating tape over the junction of each conductor where it enters the shank of the soldering lug (see Fig. 2-1). This will prevent frayed insulation, broken leads, and shorts between adjacent lugs. Check all banana jacks and plugs for tightness before attaching the lug leads; otherwise loose fittings may turn and short adjacent leads. Lace tightly into cables all leads terminating on terminal strips or on jack or plug assemblies.

Bond all external shielding (armor) at several points to the ship's common grounding strip to prevent or lessen interference between the Radar and other equipment. This bonding will also prevent static charges on the units and arcing to ground.

b. SPECIFIC INSTRUCTIONS. — Use standard Navy cable clamps at entrances where protection from moisture is not required. However, use terminal tubes at all cable entrances to the Antenna, Transmitter-Receiver, Indicator and A.C.U., since these units must be kept dry to prevent corrosion and growth of mold. Terminal tubes on the Indicator should preferably be the right-angle type. It is standard Navy practice to use stuffing tubes where cables pass through decks and bulkheads, but usage varies somewhat with different yards.

Run all cables to the Transmitter-Receiver on the same side and leave enough slack to permit removal of the Transmitter-Receiver from its mount. Lash together the cables running between the unit and the deck to prevent strain on coaxial lines.

c. COAXIAL CABLES. — All coaxial cables are fragile and must be handled with care. Do not bend large coax cables on less than an 8" radius, or small ones on less than a 6" radius. Keep them away from hot exhaust pipes, etc.

The pulse cable (No. XIV) is the only cable supplied by Raytheon. It will be an armored cable, either RG-14/U or RMA-10A. It must be made up properly with a special plug fitting for the transmitter end and a fitting for the modulator end.

6. TUBING OF EQUIPMENT.

The equipment is shipped from the factory with a full complement of tubes mounted in their proper sockets. Spare tubes are in equipment spares, and in the tender spares shipped with every 12 equipments. All tubes are equipped with locking devices to keep them from working loose under vibration or shock. Nevertheless, before any attempt is made to operate the equipment for the first time, all tubes should be checked to make sure that they are firmly seated in their sockets.

Most of the tubes are secured by spring grips which may be unlocked either by depressing the springs or by throwing a small lever. The removal of receiver tubes is explained under "Replacement of Tubes" in the Maintenance Section.

CAUTION

Special devices are used to secure the magnetron, local oscillator, and cathode-ray tubes, as well as the TR and ATR tubes. Because these tubes are fragile, no attempt should be made to replace them until the special instructions (given separately for each tube under Maintenance) have been carefully read.

7. CHECK-UP FOLLOWING INSTALLATION.

a. Check all wiring by color code and/or with a continuity meter. Make sure that all connections are properly made and are tight. Make sure that all cable terminal tubes are properly made up and are watertight. Check all cabling for proper clamping. Make sure that all exposed metal parts are thoroughly chromated and painted to prevent corrosion.

b. Check the waveguide flanges for proper assembly.

c. Check the mounting of all units (including shock mounts) for tightness.

d. Check the grounding bonds to all units and cabling.

e. Check all interlocks for tightness.

f. Make sure that the tubes in all units are firmly seated in their sockets and that all fuses and ferrule resistors are properly installed in their clips. Make sure that the plate caps on the hydrogen thyratron V-104 and the PPI tube V-407 are properly attached.

g. Check the condition of dehydrator plugs and replace if necessary.

h. Check the deflection coil drive gears in the Indicator and thoroughly clean with a brush if any dirt is found.

i. Check the polarity of the ship's supply, then start the Motor-Alternator by placing a temporary jumper across terminals 46 and 54 on E-103. Check the 60-cycle output voltage between terminals 1 and 2 on E-102 to make sure it does not exceed 115 volts.

j. Start the equipment in the normal way (see Sec. 3) and check the action of all operating controls.

k. Check the local oscillator and the r.f. system tuning. Make sure the blower motor runs properly.

l. Check the synchro alignment.

m. After the equipment has run at least 30 minutes, check for poor regulation by turning the Modulator on and off several times while watching the line voltmeter.

n. Check the magnetron current, and if not approximately 5.3 ma., correct as outlined in the Maintenance Section under *Modulator.*

8. ELIMINATION OF INTERFERENCE.

After the Radar equipment has been installed and checked, it may be found that the ship's communications equipment is picking up severe 400-cycle interference.

Interference can sometimes be eliminated by bonding between all cables and units of the communication system, Radar equipment, and ground system. The power leads to both equipments should be checked for reversed polarity.

If interference persists after other measures have been tried, the ship's ground bus should be checked to make sure that it has no breaks or high-resistance joints.

Interference is sometimes caused by poor connections in the modulator discharge circuit. There may be a loose ground bus in the Modulator. Other possible causes are a loose shield ground on the pulse cable, or arcing in the r.f. system.

Interference resulting from trouble within the Radar equipment is outlined under maintenance.

TABLE 2-1

ASSEMBLY PROCEDURE FOR COAXIAL CABLE CONNECTOR

(Stores #4D23-225; Instruction #INS-6-34-6)

MODULATOR END OF PULSE CABLE

(The identifying letters in the illustration refer to the corresponding steps below)

(a) Cut cable to correct length. Fray ends of armor over cable end. Disassemble the connector.

(b) Slip threaded sleeve over cable. Cut the armor back 7¾″.

(c) Cut the neoprene back 7¾″, taking care not to damage the inner braid, and slip the conical ferrule over the double inner braid.

(d) Force the ferrule under the neoprene and cut off the double inner braid about 1/16″ beyond the end of the ferrule. When cutting the inner braid be very careful not to damage the soft dielectric. Form the braid to the inside of the ferrule. Slip the coupling union on the cable after scraping the soft dielectric to free of foreign matter.

(e) Force the tapered portion of the coupling union under the inner braid and ferrule. Trim off excess braid and armor.

(f) Pull the sleeve toward the coupling union and screw together, tightening with open-end wrenches. Remove the soft dielectric from the last ½″ of the cable for connection.

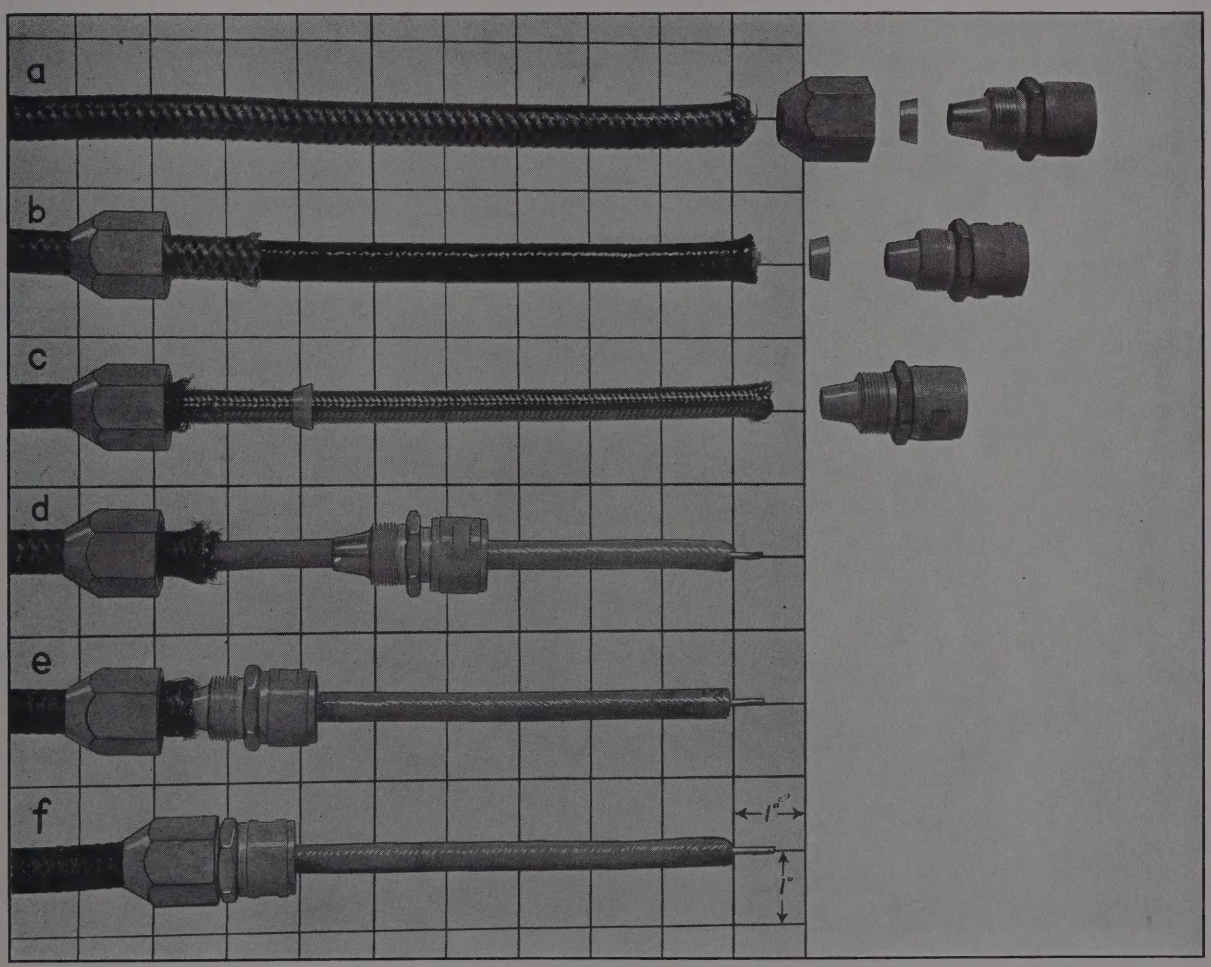
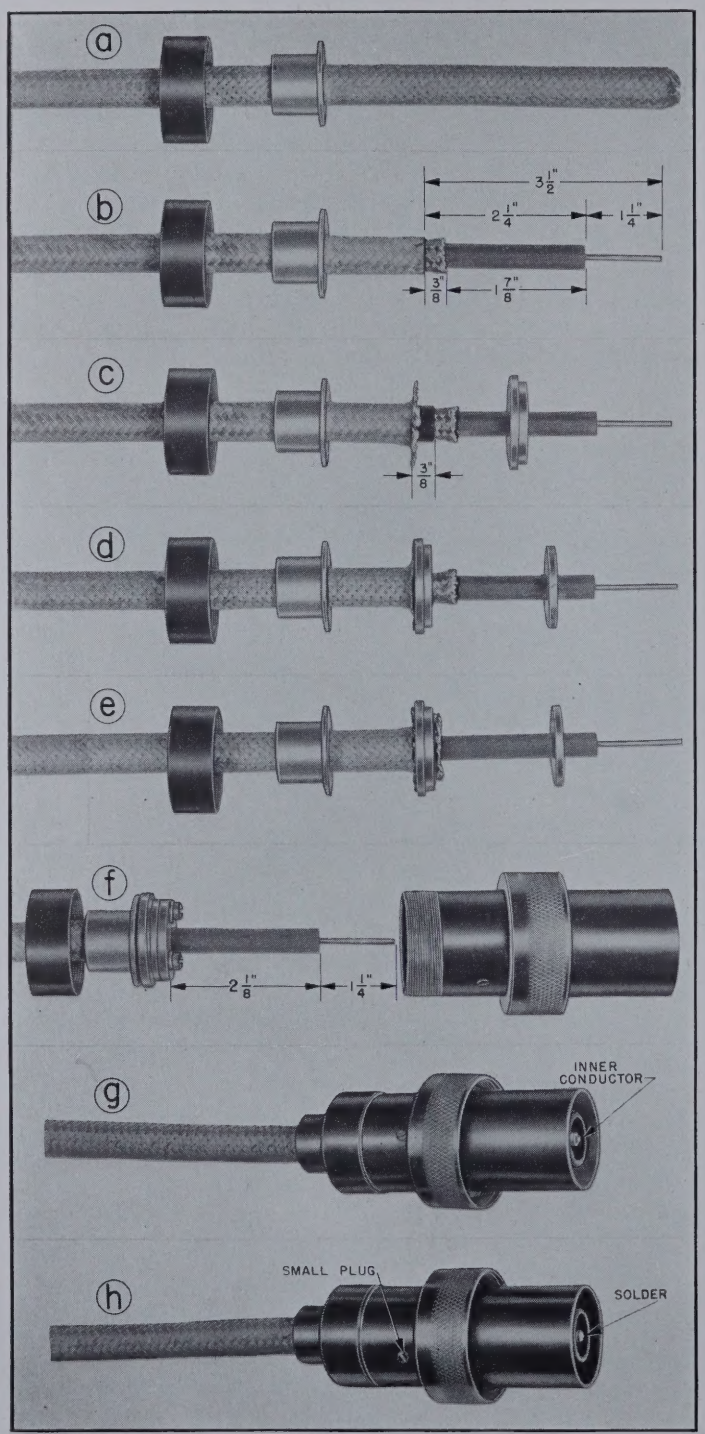


TABLE 2-2
ASSEMBLY PROCEDURE FOR COAXIAL CABLE CONNECTOR
(Stores #6-5182G2; Instruction #INS-6-36-1)
TRANSMITTER END OF PULSE CABLE

(The identifying letters in the illustration refer to the corresponding steps below)



(a) Twist the ends of the armor braid as shown, to permit sliding the nut and sleeve over the cable. (If these ends are not long enough, cut back the cable as required.) Slide the union nut and sleeve over the cable as shown.

(b) Cut back the armor, neoprene, inner braid, and insulation as shown.

(c) Unbraid the armor 3/8" and flare out as shown.

(d) Slide on the armor-grounding and braid-grounding washers as shown.

(e) Unravel the inner (copper) braid and flare out against the large washer.

(f) Push the sleeve against the flared outer braid. Push the small washer against the flared inner braid. Assemble the two braid-grounding washers with the small machine screws provided. Slide this assembly into the plug connector.

(g) Screw the union nut tightly onto the plug connector. Cut off the end of the inner conductor flush with the tip of the plug, and round off the tip with a drop of solder.

(h) Remove the small plug and, using an Alemite gun and fitting in the hole, fill the interior of the connector with Dow-Corning #4 compound. Replace the small plug.

TABLE 2-3
ASSEMBLY PROCEDURE FOR COAXIAL CABLE CONNECTOR
(Stores #6-5174GI; Instruction #INS-6-34-8)
MODULATOR END OF IFF AND TRIGGER CABLES

(The identifying letters in the illustration refer to the corresponding steps below)

(a) Cut the coax cable to the proper length. Dismantle the connector.

(b) Fray the end of the armor over the end of the cable and slip on the union nut and sleeve.

(c) Cut the armor and neoprene back 1″ from the end of the cable, taking care to avoid cutting the inner braid.

(d) Fray the inner braid over the end of the cable and slip the ferrule over the braid (tapered end first).

(e) Force the tapered end of the ferrule under the neoprene. Trim the inner braid about ⅛″ beyond the ferrule and flare over the ferrule. Cut the semi-solid dielectric so that it extends ¼″ beyond the end of the ferrule.

(f) Carefully tin the bare inner conductor with *rosin core solder* using a small soldering iron. USE THE SMALLEST POSSIBLE AMOUNT OF HEAT CONSISTENT WITH GOOD SOLDERING AS HEAT DAMAGES THE DIELECTRIC. Tin the inside of the tip conductor. Insert the inner conductor into the tip and *sweat* together. Any globules of solder on the tip must be removed. Unbraid the armor back about ⅜″ and slip the sleeve over the armor and ferrule. This fit is quite tight, and two pairs of pliers may be required to force the sleeve over the ferrule.

(g) Trim off excess armor and slip the main connector assembly into place. The tip must pass through the polystyrene bushing in the connector. Slide the union nut up and screw the connector halves together, using open-end wrenches for tightening.

NOTE: To insure a watertight assembly, the rubber washers on the ferrule and inside of the main connector assembly must be in place.

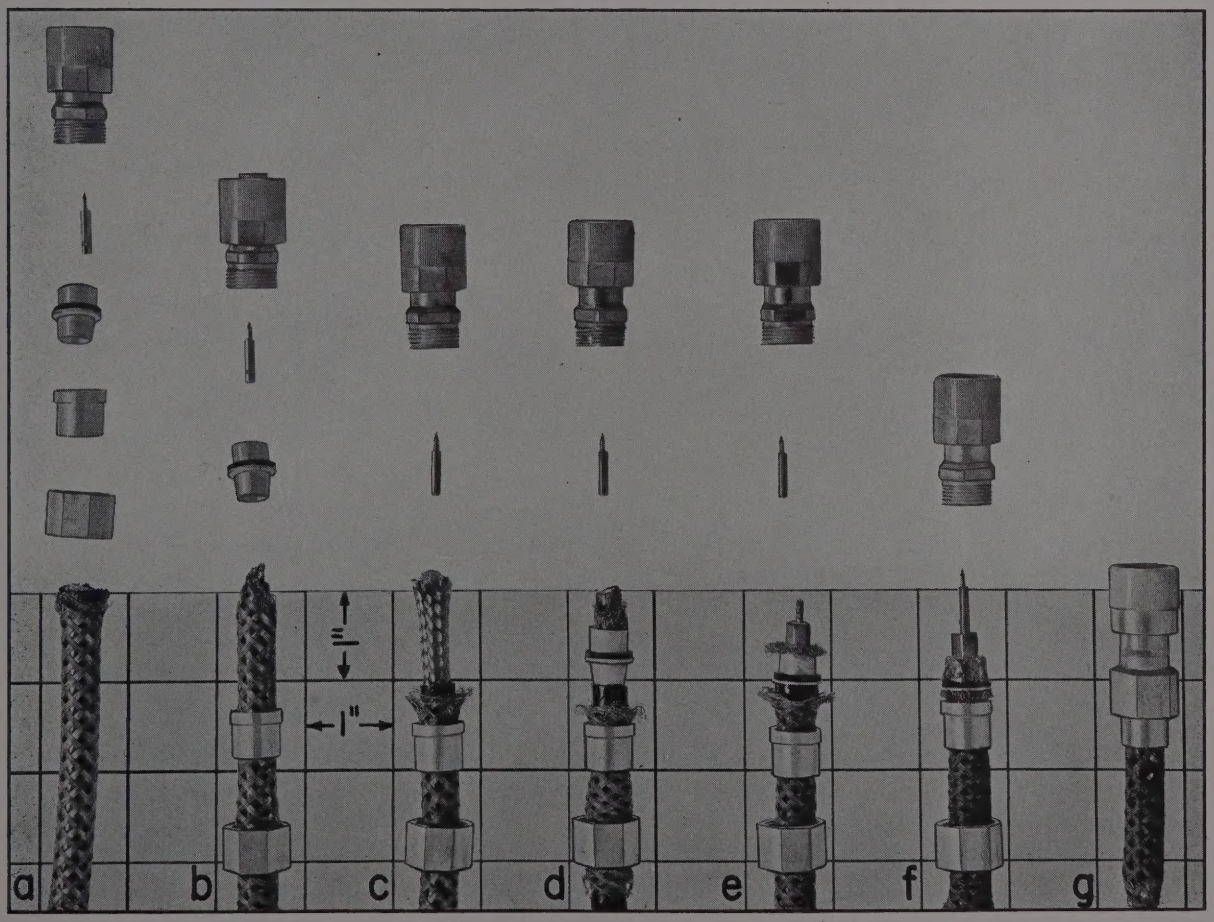


TABLE 2-4

ASSEMBLY PROCEDURE FOR COAXIAL CABLE CONNECTOR

(Stores #79-5046; Instruction #INS-11-1)

ECHO BOX END OF ECHO BOX CABLE

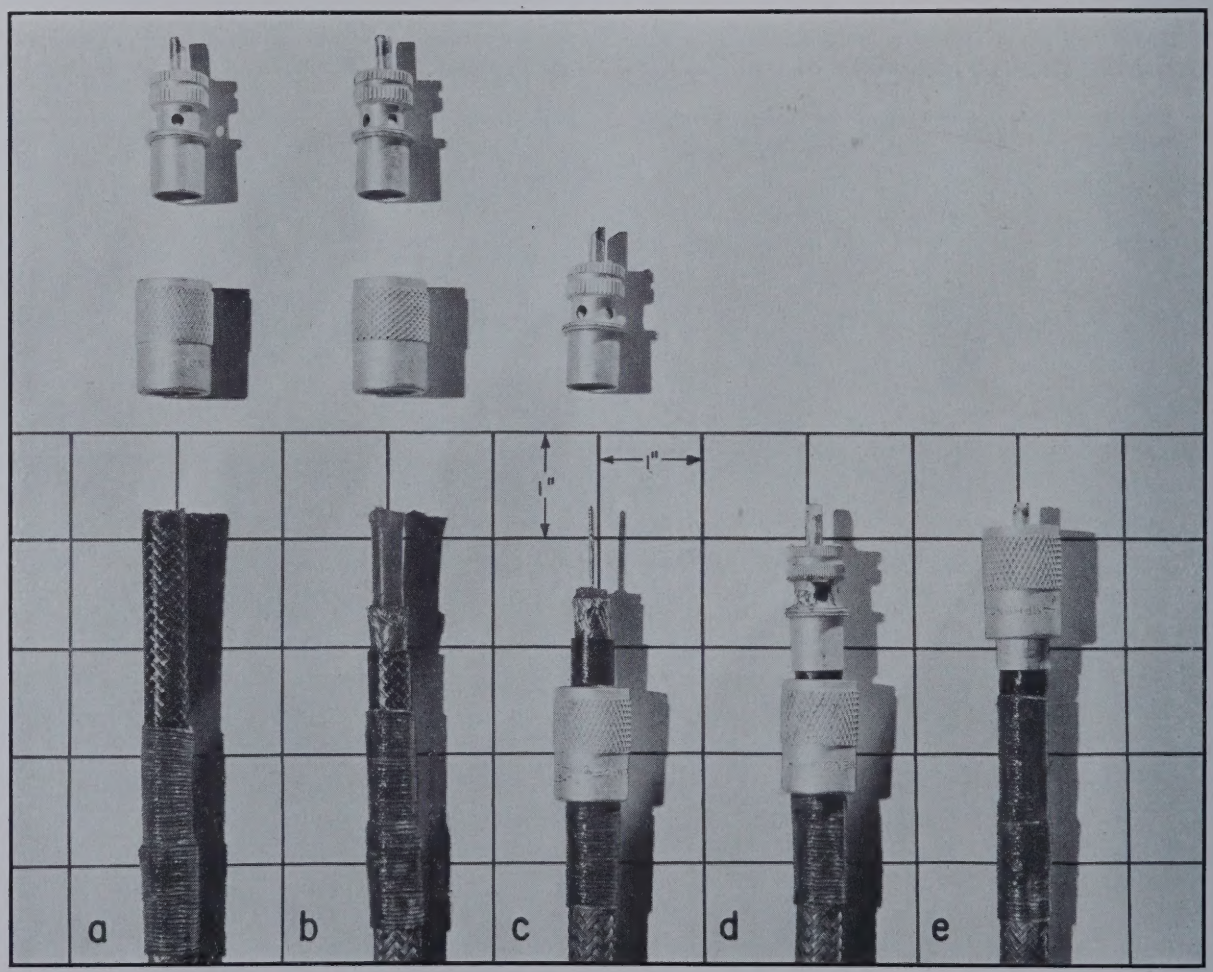
(a) Cut the cable to the proper length. Cut the armor back 3″, serve, and paint with Glyptal.

(b) Cut the neoprene back 1¼″. Cut off the inner braid ⅜″ beyond the neoprene.

(c) Cut off the dielectric ⅞″ from the braid and lightly tin the end of the braid and the exposed lead. Slip the threaded sleeve over the cable.

(d) Force the inner section of the plug onto the cable (using a twisting motion) until the braid shows through the holes, then solder in place. Avoid using excessive heat and solder, or the cable may be damaged.

(e) Pull up the threaded sleeve and screw it onto the inner section of the plug.



SECTION III. OPERATION

1. GENERAL.

Before using the equipment, the operator should learn the locations and functions of the operating controls, most of which are located on the Indicator and on the Accessory Control Unit (A.C.U.). Controls located on the Indicator and A.C.U. are shown in the photograph (Fig. 3-1) with letters or numbers keyed to the text. Controls not used during actual operation and located on other units are shown in Sections IV and V. The functions of all controls are given in Table 3-1. *List of Controls and Adjustments.*

* * *

Control names copied exactly from panel markings are capitalized thus: "MARKS Control." Control names not appearing on a panel are printed thus: "Antenna Switch."

2. STARTING THE EQUIPMENT.

WARNING

Before starting the equipment, make sure that the ship's ventilating fan is running. Failure to do so may result in a serious explosion from ignition of gasoline fumes by a spark.

With the Main Line Switch turned on, start the equipment as follows:

a. Set Normal-Emergency Switch **E** to "N" (Normal).

b. Set Antenna Switch **N** to "Off."

c. Turn GAIN Control **C** and INT (Intensity) Control **M** completely counterclockwise.

d. Press the START Button on the bulkhead-mounted START-STOP Switch.

e. Allow two minutes for the tubes to heat and for the time-delay relay to close.

f. After two minutes, press START Button **B** (on the indicator panel), thus applying high voltage to the Transmitter.

g. Check Line Voltmeter **13** (on the A.C.U. panel) to make sure that the reading is within proper limits (110 — 120 volts).

3. STOPPING THE EQUIPMENT

a. Turn INT (Intensity) Control **M** to its counterclockwise limit.

b. Press STOP Button **B** on the Indicator.

c. Press STOP Button on the bulkhead-mounted START-STOP Switch.

4. OPERATING ADJUSTMENTS.

With the equipment started as outlined above, make the following adjustments on the Indicator and A.C.U.:

a. Turn INT (Intensity) Control **M** clockwise until a radial trace line is visible on the PPI screen, then turn back the control until the trace just disappears.[1]

b. Advance GAIN Control **C** clockwise until a sparkling trace ("snow") appears.

c. Set Range Switch **J** to the 4-mile range position.

d. Set TUNE Control **H** for brightest signals.[2]

e. Set A.F.C.-MANUAL Switch **1** to "A.F.C."[3]

f. Adjust FOCUS Control **O** for sharpest signals.

g. Throw Antenna Switch **N** to either "CW" (clockwise) or "CCW" (counterclockwise) to rotate the Antenna in the desired direction. *In normal operation the Antenna should be kept rotating continuously.*

h. Set Range Switch **J** to 4, 20, or 80 miles as desired.

i. Readjust GAIN Control **C** for the desired brightness of signals.

j. Readjust FOCUS Control **O** for sharpest signals.

5. DETERMINING RANGE AND BEARING.

a. GENERAL. — Approximate range is estimated by the use of calibrated fixed range marks on the PPI screen; more accurate range is read from a dial on the A.C.U. after superimposing the movable range mark on the target.

Bearing is read from the dial surrounding the PPI screen. This is done by rotating Hand-Crank **K**

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[1]For special-purpose adjustments of INT Control **M**, see "Individual Operating Methods" in Sec. 3.8. Normally, the control should be left as set in step (*a*) above.

[2]If TUNE Control **H** peaks near either end of its range, reset this control to mid-scale and adjust TUNE SET Control **G** for optimum signals. TUNE Control **H** will then peak at the middle of its range. Note that with a.f.c. operation TUNE Control **H** has little effect.

[3]Normally, the "A.F.C." position is always used, since the Receiver is thus kept automatically tuned for optimum performance. If, however, better signals can be obtained at the "Manual" position when TUNE Control **H** is peaked, the a.f.c. circuits are faulty. In this event manual tuning should be used and the a.f.c. circuits corrected at the first opportunity.

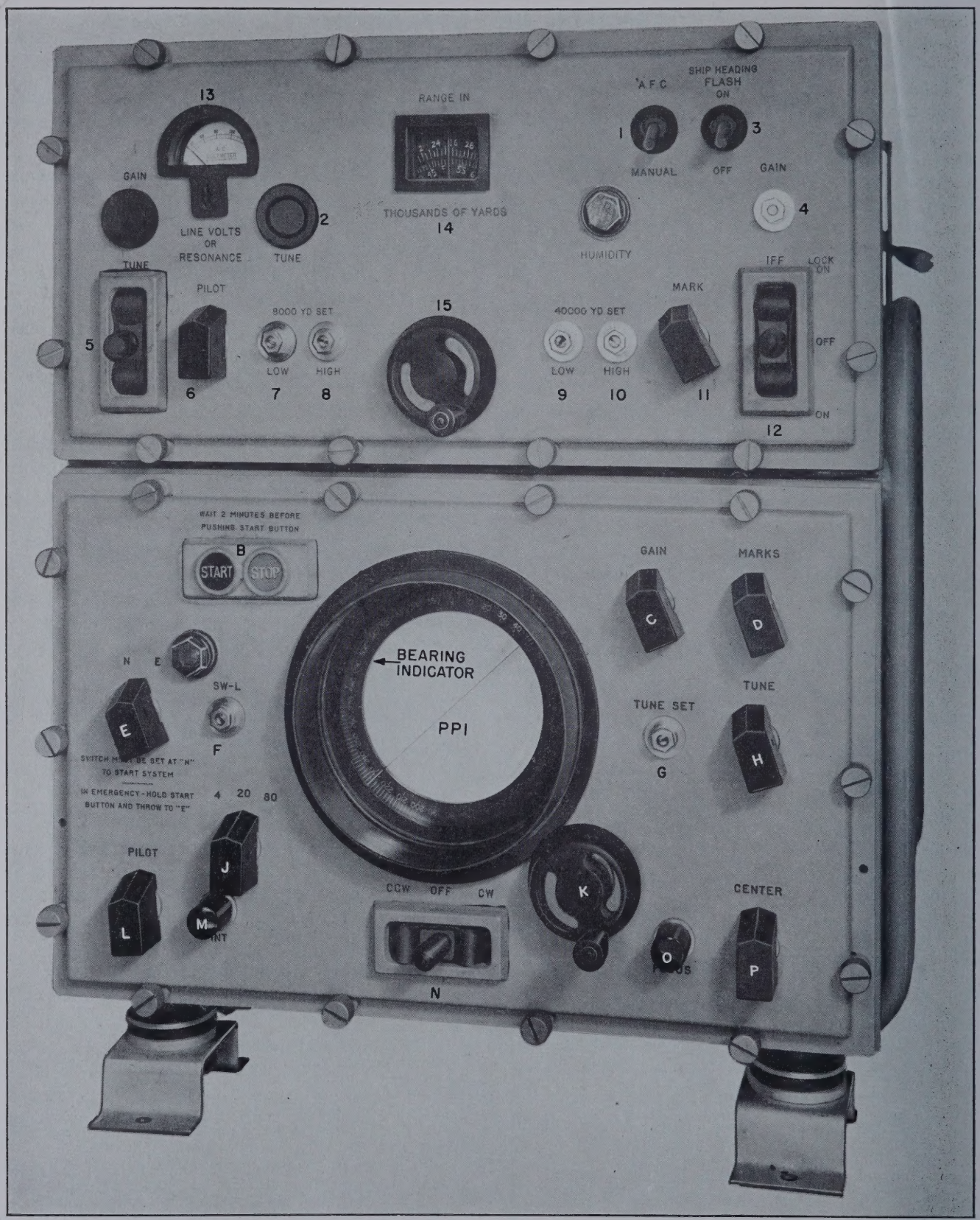


Figure 3-1—Accessory Control and Indicator Units: Control Panels

to align the bearing cursor on the middle of the target arc and reading the bearing from the dial at the point where the end of the cursor falls. This reading represents either true or relative bearing, depending on whether or not the mechanical differential in the Bearing Control Unit is locked or free to rotate. In the free position, o.s.c. and antenna bearing will be mixed to produce a resultant true-bearing reading. When locked, the differential is, in effect, merely a series coupling transformer which relays relative-bearing information from the Antenna to the Indicator.

The system can be changed from true- to relative-bearing operation or vice versa by following the indicated procedure given in the Maintenance Section under "Antenna Alignment." (Note that the change is *not* made by means of a switch.)

b. SHIP HEADING (O.S.C.) FLASH. — A means is provided for producing a momentary intensification (flash) of the PPI sweep at the instant the Antenna reaches the "own ship's course" (o.s.c.) position (i.e., when the Antenna sweeps across the ship's bow). By noting the clockwise or counterclockwise angle existing between the ship's heading flash and the target trace, relative bearing can be estimated while operating on true bearing, without actually switching over the system to relative bearing.

c. ESTIMATED RANGE.

(1) Place the range marks on the PPI screen by advancing MARKS Control **D** until the marks appear at the desired brilliancy.

The distance represented by these marks varies with the setting of Range Switch **J**. For example, with the Range Switch set on the 4-mile range position, marks are spaced at one-mile intervals; when set on the 20-mile range position, marks are spaced at 5-mile intervals; and when set on the 80-mile position, at 20-mile intervals.

(2) Estimate the range of the target by reference to these marks, keeping in mind the intervals as determined by the setting of Range Switch **J**.

d. DETERMINING RANGE ACCURATELY. — The Accessory Control Unit (A.C.U.) is required for this purpose. The controls are shown in Fig. 3-1 with numbers keyed to the text. (The A.C.U. is always on when the Motor-Alternator is running.) It is assumed that the unit is properly calibrated. If not, refer to *Calibrating the Accessory Control Unit*, Sec. III.9.

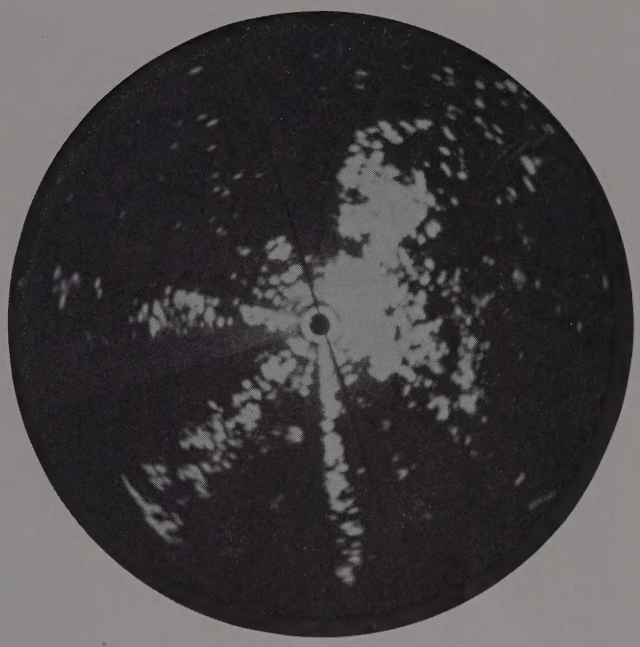


Figure 3-2—Signals on PPI Screen (20-Mile Range)

(1) Advance MARK Control **11** (on A.C.U.) to about three-quarters maximum. This control adjusts the *intensity* of the mark.

(2) Advance PILOT Control **6**, which adjusts the illumination on Range Dial **14**, until the dial is clearly visible.

(3) Rotate Range Crank **15** until the movable range mark exactly coincides with the ranged signal.

Figure 3-3—Signals and Range Marks on PPI Screen (80-Mile Range)

Note

The movable range mark can be shifted at will by rotating the Range Crank. When the mark falls exactly on a target signal, the latter brightens appreciably, thus showing correct alignment. It may be necessary to readjust MARK Control **11** to obtain the clearest indication, i.e., the best balance between marks and signals.

(4) Read the range on Range Dial **14**.

Note

This dial has two scales: a 40,000-yard scale for long ranges and an 8000-yard scale for short ranges. When Range Switch **J** (on the Indicator) is set either to the 20-mile or to the 4-mile position, the corresponding scale on Range Dial **14** is automatically illuminated and the other scale does not appear. Range Dial **14** is not used when Range Switch **J** is set to the 80-mile position.

e. DETERMINING TRUE BEARING.

(1) Advance PILOT Control **L** until the dial is clearly visible.

(2) Rotate Bearing Crank **K** until the bearing cursor bisects the signal trace on the PPI.

(3) Read the true bearing from the Bearing Dial surrounding the screen.

Note

Obviously, true-bearing readings cannot be obtained unless the ship's gyro compass is operating. It should also be remembered that the accuracy of any true-bearing system is dependent upon the accuracy of the compass to which it is coupled. Any factors affecting the accuracy of the compass will similarly affect the true-bearing system.

If the ship's compass is inoperative, connect it to the system and align the step motor, as outlined in Sec. V under *Antenna Alignment*.

f. DETERMINING RELATIVE BEARING.

(1) Lock the differential as outlined in Sec. V under *Antenna Alignment*.

(2) Advance PILOT Control **L** (on the Indicator) which adjusts the illumination on the Bearing Dial, until the dial is clearly visible.

(3) Rotate Bearing Crank **K** until the bearing cursor bisects the signal trace on the PPI screen.

(4) Read the relative bearing from the Bearing Dial surrounding the screen.

Note

With true-bearing systems, relative bearing can still be read while the system is operating on true bearing. This is done with SHIP HEADING FLASH Switch **3** (on the A.C.U.) on, by noting the clockwise angle existing between the heading flash and the target trace, i.e., by subtracting o.s.c. from the target's true bearing.

6. EMERGENCY OPERATION.

N-E (Normal-Emergency) Switch **E** is used to restore operation in case the Transmitter overheats, causing protective thermostat S-301 to disconnect the normal high-voltage control circuits. *The "E" (emergency) position should be used only when continued operation of the equipment is more important than damage to the Transmitter.*

To shift from normal to emergency operation, the START Button on START-STOP Switch **B** should be held in while turning N-E Switch **E** from "N" to "E."

Note

If by accident the STOP Button on Switch **B** is pressed or the Main Line Switch is opened, the equipment will become inoperative. In this event the N-E Switch must be turned back to "**N**," after which the Modulator can be restarted as outlined above.

7. OTHER OPERATING CONTROLS.

a. MODULATOR. — Repetition Rate Control R-173 (visible on front panel) is used to vary the pulse repetition frequency to minimize interference seen on the PPI.

b. PLAN POSITION INDICATOR. — SW-L (Sweep Length) Control **F** is mainly used to compensate for differences in sweep amplifier tubes. It is usually adjusted so that five range marks (including the first or 0-mile mark) appear on the PPI screen. This control can also be used to expand the scale of the PPI screen. To do this, the control is adjusted so that less than five marks appear on the screen. This adjustment does not affect the range mark intervals on the Indicator or the calibration of the A.C.U.

PILOT Control **L** is used to adjust the lighting of the bearing dial to prevent masking of the PPI screen by excessive light.

CENTER Control **P** is used to displace the start of the sweep from its normal location at the center of the PPI screen. When the sweep starts at the exact center of the screen, signals from nearby targets are crowded into a small area, making identification difficult. Clockwise rotation of CENTER Control **P** displaces the start of the sweep to make traces from nearby targets occupy more of the screen area. This adjustment does not affect the range mark intervals on the Indicator or the calibration of the A.C.U. When the sweep start is off-center, the entire circular area at the center represents the ship's position.

Antenna Switch **N** selects either clockwise or counterclockwise rotation of the Antenna as desired. In normal operation the Antenna should be kept rotating continuously, although for some purposes, such as when making tuning adjustments, the Antenna should be stopped.

The OFF-ON Switch is omitted from the upper left-hand corner of the panel and is replaced by a plug. Power is controlled by a separately-mounted Main Line Switch.

c. ACCESSORY CONTROL UNIT. — Range Crank **15** adjusts the position of the movable range mark on the PPI screen to coincide with the signal to be ranged. The crank is mechanically coupled to Range Dial **14**. This dial accurately indicates the range of a target. It has two scales, one or the other of which is automatically illuminated when Range Switch **J** (on the Indicator) is set to the corresponding range position. PILOT Control **6** adjusts the illumination on Range Dial **14**. MARK Control **11** adjusts the brilliance of the movable range mark.

LOW Control **7** and HIGH Control **8** ("8000 YD SET") and LOW Control **9** and High Control **10** ("40,000 YD SET") are used to calibrate the range limits in the A.C.U. The calibration is made against the PPI range marks.

Line Voltmeter **13** indicates the output voltage of the 60-cycle Alternator, or shows resonance of the Echo Box when TUNE Button **2** is held in.

SHIP HEADING FLASH Switch **3** turns the flasher circuit on and off.

IFF Switch **12** (supplied) and GAIN Control **4** (not supplied) are both used to control external IFF equipment. IFF Switch **12** has three positions: "Lock On" (a locking position); "On" (a non-locking or keying position); and "Off."

TUNE Button **2** switches Meter **13** from Line Voltage to Resonance indication to show when the remote-tuned Echo Box is in tune. TUNE Switch **5** operates the tuning motor on the Echo Box, either clockwise or counterclockwise as desired. A.F.C.-MANUAL Switch **1** changes from automatic to manual tuning of the local oscillator.

d. MAIN LINE SWITCH. — This switch controls the ship's d.c. supply to the Motor-Alternator. It is opened when the equipment is secured and during certain servicing operations.

8. USE OF RESONANCE CHAMBER.

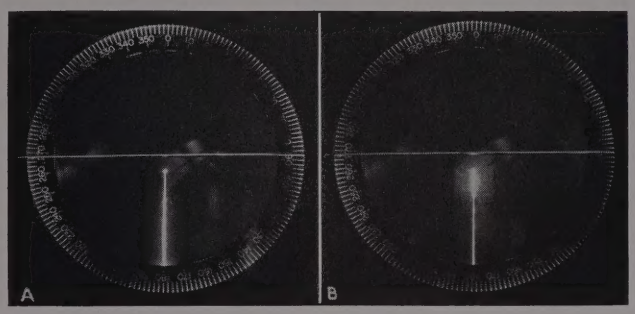


Figure 3-4—Resonance Chamber Signals (A) Receiver detuned; (B) Receiver tuned

In the absence of actual targets or at the discretion of the operator, the Receiver can be tuned with the aid of the Resonance Chamber (Echo Box). The Echo Box must be remotely tuned for use by means of controls on the A.C.U., as follows:

a. Hold in TUNE Button **2**, thus switching Meter **14** from Line Voltage to Resonance indication. Also *hold down* TUNE Switch **5**, thus operating the tuning motor on the Echo Box.

b. Observe the reading of Meter **13**, which should be between three-quarters and full-scale. When the meter begins to dip toward zero, the Echo Box is approaching resonance; this may require 30 to 45 seconds for the initial tuning.

c. When the meter needle passes minimum and begins to rise, throw TUNE Switch **5** to the upward position, thus reversing the tuning motor, until the meter reading returns to minimum. Then return Switch **5** to the middle (off) position.

Note

It may be necessary to repeat steps *b* and *c* to stop the motor exactly at the resonance point.

d. Release TUNE Button **2** and set A.F.C.-MANUAL Switch **1** to "Manual."

e. While observing the PPI screen, and with GAIN Control **C** set at or near maximum, adjust TUNE Control **H** for maximum artificial echo signal, i.e., for longest and brightest signal trace.

Note

With the Antenna stopped (Antenna Switch **N** at "Off"), the signal will appear as a solid line extending from the center of the tube to about the one-mile position. With the Antenna rotating in either direction (Antenna Switch **N** at "CW" or "CCW"), the signal will appear as a solid "doughnut" of about one-mile radius.

f. Throw TUNE Switch **5** to the upward position for 5 seconds or so, thus detuning the Echo Box, then return the switch to the middle (off) position.

g. Return A.F.C.–MANUAL Switch **1** to "A.F.C."

9. CALIBRATING THE ACCESSORY CONTROL UNIT.

The A.C.U. should not be calibrated until the equipment has been in operation for at least 30 minutes. The calibration should be checked every few hours.

a. CALIBRATING THE 4-MILE RANGE.

(1) Set Antenna Switch **N** (on the Indicator) to "Off" and turn GAIN Control **C** to its counterclockwise limit.

(2) Advance MARKS Control **D** until small marks appear on the PPI screen. Adjust FOCUS Control **O** for maximum sharpness of these marks.

(3) With Range Switch **J** set on the 4-mile position, adjust **SW-L** (Sweep Length) Control **F** so that at least five marks (including the first or 0-mile mark) appear on the screen.

(4) Adjust MARK Control **11** for proper brilliance of the *movable range mark*. This is best done when the mark and range marks do not coincide in position.

(5) Rotate Range Crank **15** until Range Dial **14** reads exactly 2000 yards. (2000 yards equals one Radar mile.)

(6) Adjust LOW Control **7** ("8000 YD SET") until the movable mark and the one-mile range mark exactly coincide.

(7) Rotate the Range Crank until the Range Dial reads exactly 8000 yards, then adjust HIGH Control **8** ("8000 YD SET") until the movable mark and the 4-mile mark coincide.

(8) Repeat steps (6) and (7) several times, since these two adjustments are reactive.

b. CALIBRATING THE 20-MILE RANGE.

(1) Set Range Switch **J** to the 20-mile position, and rotate the Range Crank until the Range Dial reads exactly 10,000 yards.

(2) Adjust LOW Control **9** ("40,000 YD SET") until the movable mark and the 5-mile range mark coincide.

(3) Rotate the Range Crank until the Range Dial reads 40,000 yards, then adjust HIGH Control **10** ("40,000 YD SET") until the movable mark coincides with the 20-mile mark.

(4) Repeat steps (2) and (3) several times since the two adjustments are reactive.

The A.C.U. is now calibrated and ready for use in determining range accurately at points between the PPI range marks.

While the A.C.U. ranging system may be used with Range Switch **J** on the 80-mile range, its use is limited to the first 20 miles, since the mark will cover only the first quarter of the sweep. Use of the A.C.U. on the 80-mile sweep is not recommended.

10. NOTES ON OPERATION.

a. RANGE AND PERFORMANCE. — The maximum range of the equipment is normally slightly greater than the optical horizon as viewed from the Antenna. The strength of the received echo generally depends upon the size and shape of the target, its distance and height, and the material of which it is made. No difficulty should be experienced in receiving echoes from small objects such as very small craft, periscopes, bell buoys, etc., at moderate ranges; while larger objects such as large ships, land, aircraft, etc., usually give strong echoes at distances up to and exceeding the optical horizon.

b. FEATURES OF X-BAND OPERATION. — Two principal advantages are provided by X-band equipment over S-band Radars. The beam radiated by an antenna of any given size is sharper, and the beam radiated by a much smaller antenna than conventional S-band models is equally sharp. Furthermore, the beam does not leave the surface of the water as soon (in distance) as does an S-band beam. Consequently, *small* targets on the surface of the water are visible for a greater distance on the X-band. *Large* surface targets (such as destroyers, cruisers, etc.) or low-flying aircraft are observed equally well on either band.

c. SKILL OF OPERATOR. — Success in *identifying* echo signals depends in large measure upon the skill of the operator. A well-trained operator is able to pick out weak echoes that would otherwise go unnoticed; and he can often identify the nature of the target from the echo trace. In addition, he can

often determine the approximate course and speed of moving objects.

d. MINOR LOBES. — At ranges under two miles, a strong signal sometimes appears on the PPI as three or more targets. This is due to reception from minor lobes radiated by the Antenna on each side of the main beam (see Figs. 4-22 and 4-23). The Antenna has been designed to reduce these lobes as much as the present state of the Radar art permits; and once the lobe effect is recognized, no confusion should result. When tracking objects at very short ranges, these false signals may be reduced or eliminated by operating with GAIN Control **C** about halfway open.

e. INDIVIDUAL OPERATING METHODS. — Methods of operation will vary with individuals, one method being perhaps as good as another. At the factory, for example, where strong ambient light is encountered, test men prefer to set INT Control **M** so that a very faint trace of the radial sweep shows when GAIN Control **C** and MARKS Control **D** are fully retarded. Maximum response from weak signals is then obtained when GAIN Control **C** is advanced.

Most operators like to work with GAIN Control **C** far enough advanced to produce strong signals with the "snow" effect barely visible on the PPI. This insures a clean screen.

For navigation purposes, however, short-range targets can be observed more clearly if GAIN Control **C** is left about halfway open. This setting prevents "filling-in" of the PPI from sea-return and false signals from minor lobes.

When searching for faint or distant targets, MARKS Control **D** should be turned back until the range marks are barely visible or invisible. Faint targets will then show up clearly. When targets are fairly bright, range marks may be left turned up.

Unsteady or weak targets can be brightened on the PPI by sector scanning. This is done by snapping Antenna Switch **N** from "CW" to "CCW" and back again every few seconds, thus sweeping the antenna beam back and forth over a small sector of the horizon. *Owing to tactical considerations, sector scanning should be employed only as directed by the Captain or Radar Officer.*

f. SPECIAL PHENOMENA. — The SO-4 Radar, like other Radar equipment, is subject to certain peculiar phenomena. Rain squalls and clouds often produce a lacelike echo on the PPI as the result of their imperfect reflection characteristics. This type of echo may often provide worth-while weather information.

When nearby targets are present, multiple reflections sometimes occur between the ship and the target. The result is a rapidly damped series of echoes spaced by the interval between the ship and the target. This effect should cause no confusion.

TABLE 3-1.—LIST OF CONTROLS AND ADJUSTMENTS

Control names copied exactly from panel markings are capitalized thus: "MARKS Control." Control names not appearing on a panel are printed thus: "Bearing Crank." Letters and numbers following these names as listed in the left-hand column are keyed to the photograph of the control panels.

Marking	*Symbol and Value*	*Function*	*Location* (on front panel)
		MODULATOR UNIT	
Battle Switch	S-103	Shunts interlock switch and controls neon warning lamp	Front right center
Repetition Rate Control	R-173 (2,000 ohms)	Controls frequency of rep. rate oscillator	Knob adjustment
		PLAN POSITION INDICATOR	
START-STOP **B**	S-405	Main switch for Modulator	Push-button switch, upper left
GAIN **C**	R-498 (10,000 ohms)	Controls receiver gain	Knob, upper right
MARKS **D**	R-455 (10,000 ohms)	Controls marks intensity	Knob, upper right
N–E **E** (Normal-Emergency)	S-404	Controls transmitter plate voltage for emergency operation	Knob, left center
SW–L **F** (Sweep Length)	R-423 (500 ohms)	Adjusts sweep speed (length per unit time)	Screwdriver adjustment, left center

LIST OF CONTROLS AND ADJUSTMENTS (Continued)

Marking	*Symbol and Value*	*Function*	*Location* (on front panel unless otherwise noted)
TUNE SET **G**	R-494 (20,000 ohms) (dual)	Controls receiver tuning by coarse adjustment of repeller plate voltage of local oscillator	Screwdriver adjustment, right center
TUNE **H**	R-497 (100,000 ohms)	Controls receiver tuning by vernier adjustment of repeller plate voltage of local oscillator	Knob, right center
Range **J** 4-20-80 (Miles)	S-401	Selects range	3-position switch, lower left
Bearing Crank **K**		Adjusts bearing cursor	Hand-crank, lower right
PILOT **L**	R-441 (15 ohms)	Controls dial light intensity	Knob, lower left
INT **M** (Intensity)	R-459 (15,000 ohms)	Controls PPI intensity	Knob, lower left
CCW–OFF–CW **N**	S-402	Controls antenna rotation	3-position lever switch, lower center
FOCUS **O**	R-468 (15,000 ohms)	Controls PPI focus	Knob, lower right
CENTER **P**	R-421 (3,000 ohms)	Adjusts starting position of PPI sweep	Knob, lower right
R-429	R-429 (10,000 ohms)	Controls multivibrator bias	Screwdriver adjustment on chassis, left front
		ACCESSORY CONTROL UNIT	
A.F.C.– MANUAL **1**	S-706	Switches a. f. c. circuit	Upper right
TUNE **2**	S-701	Switches M-701 from line voltage to echo box resonance indication	Left center
SHIP HEADING FLASH **3**	S-704	Controls ship heading flash	Toggle switch, upper right
GAIN **4**	R-750	Controls IFF gain	Knob, right center (supplied by Navy)
TUNE **5**	S-705	Controls tuning of Echo Box	Lower left
PILOT **6**	R-744 (50 ohms)	Controls dial light intensity	Knob, lower left
8000 YD SET: LOW **7**	R-722 (5000 ohms)	Aligns A.C.U. ranging to Indicator	Screwdriver adjustment, lower left
8000 YD SET: HIGH **8**	R-713 (5000 ohms)	Aligns A.C.U. ranging to Indicator	Screwdriver adjustment, lower left
40,000 YD SET: LOW **9**	R-723 (5000 ohms)	Aligns A.C.U. ranging to Indicator	Screwdriver adjustment, lower right
40,000 YD SET: HIGH **10**	R-714 (5000 ohms)	Aligns A.C.U. ranging to Indicator	Screwdriver adjustment, lower right
MARK **11**	R-734 (200–200 ohms)	Controls intensity of movable range mark	Knob, lower right
IFF **12**	S-703	Switches IFF equipment	Lower right
LINE VOLTS OR RESONANCE **13**	M-701	Indicates alternator output voltage or echo box resonance	Meter, upper left
R-707 (Range Pot.)	R-707 (20,000 ohms)	Adjusts position of movable range mark	Hand-crank, lower center
Range Dial **14**		Indicates accurate range	Upper center
Range Crank **15**	R-707 (20,000 ohms)	Adjusts position of movable range mark	Hand-crank, lower center
		RECTIFIER POWER UNIT	
R-211	R-211 (20,000 ohms)	Adjusts voltage to terminal 33	Fuse and resistor panel (inside front cover)
R-219	R-219	Adjusts voltage to terminal 48	Fuse and resistor panel (inside front cover)
Battle Switch	S-202	Disconnects main power supply	Cover of unit

SECTION IV. THEORY OF OPERATION.

1. DISTRIBUTION OF POWER.

The ship's 115-volt d.c. supply is converted to 115 volts a.c. through the Motor-Alternator. This power passes to the Modulator, where it is distributed through fused circuits to the various units.

All tube heater voltages are stepped down through transformers from the primary source. The 24-volt d.c. relay control voltage is the output of a selenium rectifier supplied by a step-down transformer. The 115-volt d.c. supply for the antenna drive motor is obtained from the main 115-volt d.c. supply.

High-voltage d.c. supplies are obtained by stepping *up* the 115-volt a.c. source, which is then rectified by vacuum tubes and filtered.

2. MOTOR-ALTERNATOR.

The Motor-Alternator is of conventional design. The d.c. drive motor is compound wound. The d.c. supply is used as excitation for the Alternator.

3. MOTOR-ALTERNATOR CONTROL UNIT.

This unit serves both as a starting control and as a speed and voltage regulator for the Motor-Alternator. Refer to schematic diagram W-71A-X6. Pressure on one of the Start–Emergency Run Push Buttons at either control station energizes the time-delay accelerating contactor coil K-2003.

In detail, the starting sequence is as follows: The accelerating resistor R-2002 is inserted in series with the motor armature by the opening of the main contacts of the time-delay accelerating relay; one set of auxiliary time-delay accelerating contacts closes to shunt the speed-regulator resistors in the motor field circuit; a set of auxiliary contacts closes to shunt the speed-regulator resistors in the motor field circuit; a set of auxiliary contacts closes to shunt the 5-mfd. capacitor C-2002 out of one winding of the speed-regulator torque-motor circuit Z-2002, leaving the reactor L-2001 in the circuit (thus unbalancing the torque motor to place the sectors in the "all resistance out" position); and a set of auxiliary contacts on K-2003 closes to energize the first main contactor K-2002.

The energizing of the first main contactor closes a set of auxiliary contacts (K-2002E). Another set (K-2002F) opens, removing the short circuit from the speed-regulator regulating resistance, and the last set (K-2002G) closes to energize the field failure relay K-2004, the motor field, and the generator field. Contacts K-2002E are required for emergency operation when overload relay contacts K-2005 are open owing to tripping of the relay.

The energizing of the field failure relay opens its corresponding contacts in the coil circuit of the second main contactor K-2001, thus energizing the coil of the second main contactor. A set of auxiliary contacts closes to by-pass the Start–Emergency Run Push Button to maintain the control circuit.

When the Start–Emergency Run Push Button is released by the operator, the economizing resistor R-2001 is inserted in series with the two main contactor coils. Another set of normally-closed auxiliary contacts on the second main contactor open, de-energizing the coil of the time-delay accelerating contactor. The main contacts of the second main contactor close, energizing the motor armature with its series-connected accelerating resistance. The inverter armatures now start to rotate with an initial inrush current of 268% of the full load value (approximately 70 amps.).

The armature of the time-delay accelerating contactor K-2003 is released by the pole-piece 3.5 seconds after the time-delay accelerating contactor was de-energized. This action closes the main contacts of the time-delay accelerating relay, which shunts accelerating resistor R-2002, thus connecting the motor armature across the line. Consequently, another inrush of 268% of full load current is received by the motor armature, which accelerates the motor to its rated speed.

At the same time, two sets of closed contacts open on the time-delay accelerating relay. One of these sets inserts capacitor C-2002 in series with reactor L-2001 in one winding of the speed-regulator torque motor; the other set inserts the speed-regulator resistors in series with the field failure relay K-2004 coil and the motor field. Thus, as the motor picks up speed it is under the control of the speed regulator.

During acceleration, the generator speed is below normal, and torque is developed on the speed-regulator torque motor in the proper direction to move the sectors in such a way as to increase the speed of the motor to normal. (The circuit constants are so adjusted that at normal speed [frequency] the currents in the two torque-motor phases of the speed regulator are in phase and no torque is developed.)

Since the alternating current output is always under automatic regulator control, the voltage regulator is permanently in circuit. The torque-

motor windings are connected to the alternator output and its resistors are connected in series with the alternator field. One winding of the torque motor has a series capacitor C-2001, and resistor R-2004 is in series with the other torque-motor winding. This arrangement is necessary because the torque motor is supplied from a single-phase bus, and one motor phase must be displaced from the other phase to develop torque in the motor.

In operation, when the generator voltage is low (during acceleration) the main spring in the voltage regulator turns the sectors to cut resistance out of the generator field circuit. As the driving motor picks up speed, torque is developed in the torque-motor rotor, turning the sectors in the proper direction to cut-in resistance in the alternator field circuit.

The motor torque and main spring settings are adjusted at the factory so that the same voltage is required to balance the rotor against the counter-torque of the main spring for any rotor position. If an external change (such as in generator voltage, load, or internal field resistance due to temperature) causes a change of torque on the regulator motor rotor, the rotor will move the sectors in such a direction as to cut the generator field resistance in or out and re-establish the set voltage at a new position of the rotor.

The voltage-adjusting rheostat R-2005, mounted on the starter panel, is used for voltage adjustment of the alternating current output. This rheostat is connected in series with the windings of the voltage-regulator torque motor.

Should an overload occur, overload relay K-2005 will open its corresponding normally-closed contacts in the starting circuit, de-energizing the main contactors and thereby shutting down the whole system.

If the current in the motor field circuit should drop below a pre-determined value, the armature of the field failure relay K-2004 is released and its corresponding contacts close in the circuit of one main contactor coil which, when de-energized, will open its corresponding contacts to de-energize the second main contactor coil — thus de-energizing the whole system.

In shutting down, pressure on one of the Stop Push Buttons shorts the coil of main contactor K-2001, opening the supply and thus shutting down the whole system.

For emergency operation the Start–Emergency Run Push Button on a control station is pressed down *and held down* during the entire period of emergency run. This action by-passes the contacts of the opened overload relay K-2005.

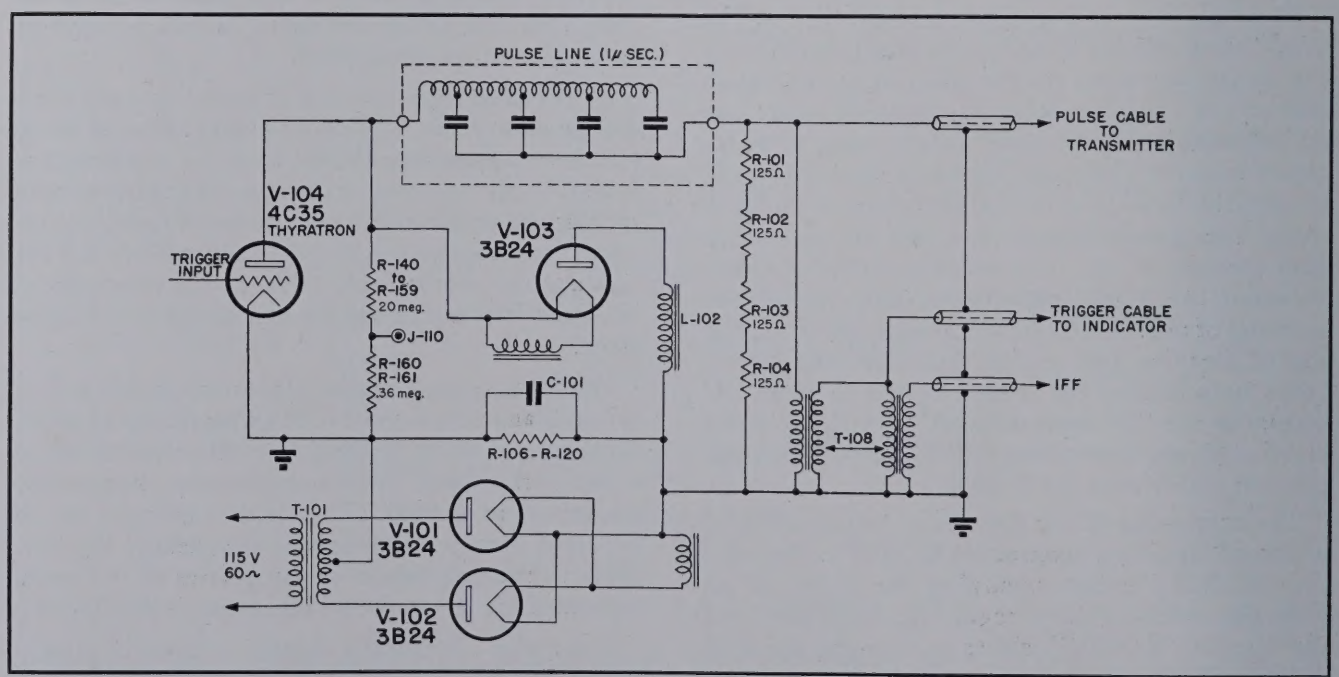


Figure 4-1—Pulse-Forming Circuits

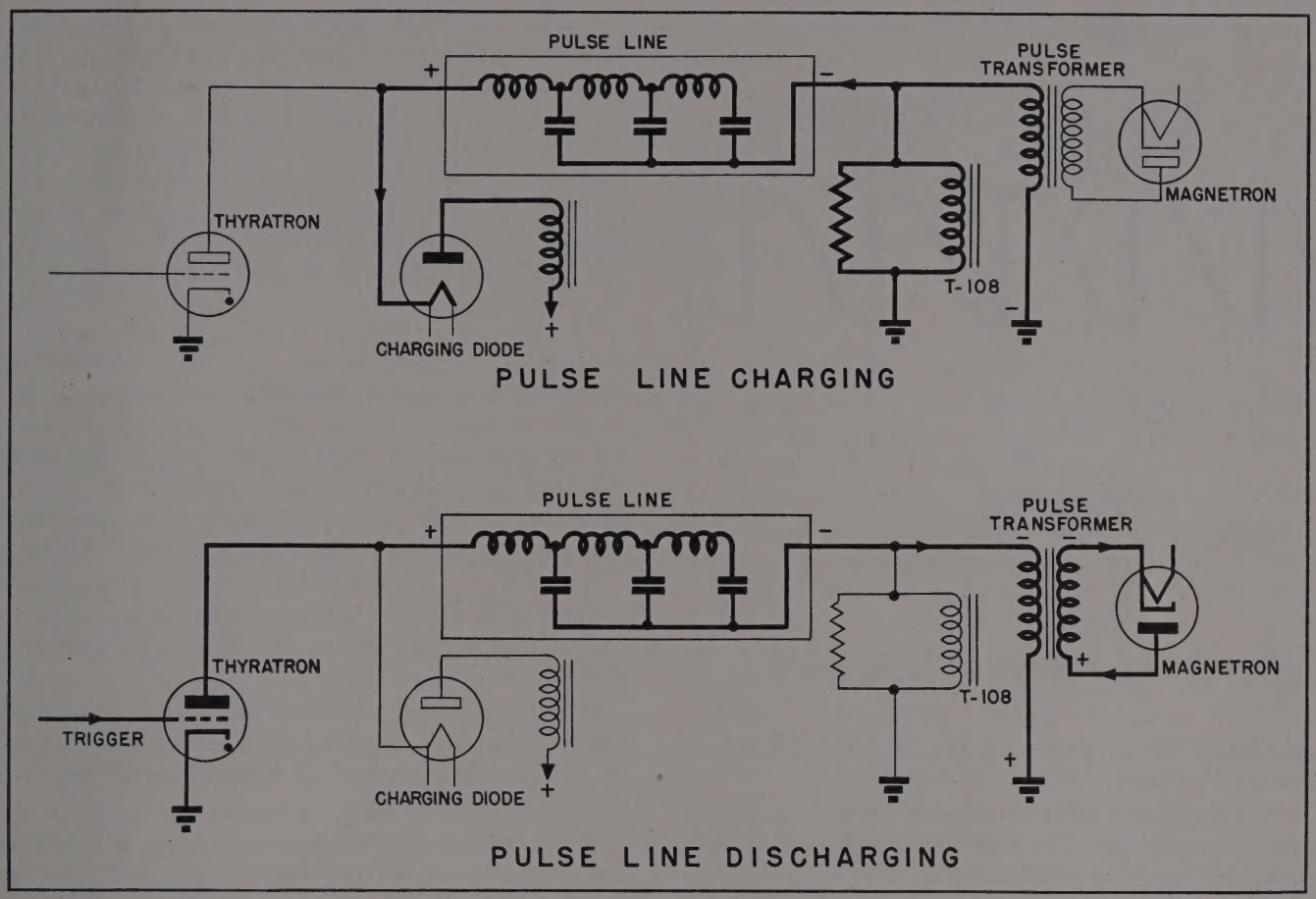


Figure 4-2—Modulator Action

4. MODULATOR.

The function of the Modulator is to develop a medium-voltage square-wave pulse of one-microsecond duration at a repetition rate of approximately 465 cycles pulses per second.

The Modulator is a line-type soft-tube pulser employing a d.c. charging system. The repetition rate is adjustable between 450 and 480 pulses per second by means of a potentiometer (R-173). The keying tube is a hydrogen thyratron (V-104) which is in effect an electronic switch with a trigger circuit comprising V-105 and V-106.

The supply voltage is stepped up by transformer T-101 and applied to a full-wave rectifier. The rectified voltage stores energy in a filter capacitor, charging it to about 3.24 kv. This voltage then charges the pulse-line capacitors through choke L-102 and blocking diode rectifier V-103. Choke L-102 alternately stores and delivers energy during the charging cycle, and charges the pulse-line capacitors to a voltage approximately twice the supply. Blocking diode V-103 prevents the capacitors from discharging into the supply circuit.

The thyratron tube, triggered by a repetition rate oscillator, discharges the pulse-line capacitors through the pulse-line inductors, producing a square wave of one-microsecond duration.

The pulse-line capacitors discharge according to the characteristic of the pulse line. As this line is terminated in its characteristic impedance, it will pass a practically uniform current for one microsecond. Choke L-102 is of sufficient size to minimize the current flow from the supply rectifier to ground during discharge.

Connected in series with the pulse line and thyratron is the primary of the pulse transformer T-301, located in the Transmitter. When the thyratron fires, a 3.5-kv. discharge current passes through the primary of the pulse transformer. As the pulse line discharges, the voltage developed across the pulse transformer is a one-microsecond square wave. The pulsed voltage is stepped up to about 13 kv. and keys the magnetron oscillator V-301.

In an ideally-terminated pulse line, the voltage developed across the termination (load) would be

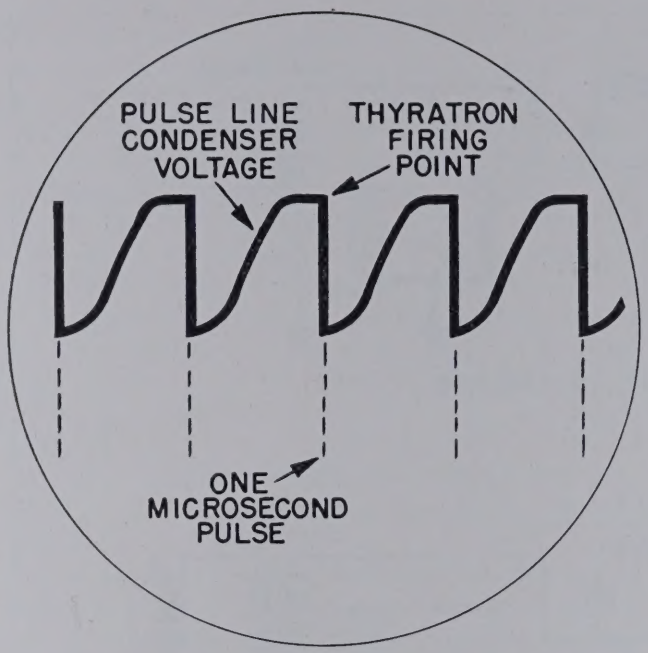


Figure 4-3—Waveform of Charging Voltage

one-half the terminal voltage of the pulse line before discharge.

A breakdown of the trigger circuit shows a blocking oscillator (V-106) whose frequency is determined by the constants C-102, R-172, and R-173, the latter being the series resistors between the grid and cathode of V-106. R-172 (a screwdriver adjustment) is used to establish the upper limit of the repetition frequency; R-173 (the knob control on the front panel) is used to vary the frequency downward from this limit. Specifically, the controls are adjusted as follows at the factory: R-173 is first set to give maximum repetition frequency at some arbitrary setting of R-172, then the latter control is adjusted to produce a repetition frequency of 480 c.p.s. Finally, R-172 is locked and sealed with Glyptal at this setting. At any time thereafter, R-173 may be adjusted to vary the repetition frequency between 480 and 450 c.p.s.

Transformer T-105 constitutes grid-to-plate coupling for the blocking oscillator and also provides a means of coupling it to V-105, the cathode follower. The follower output is coupled through C-105 to transformer T-106, which serves as a 4-to-1 transformer driving the grid of the thyratron V-104. A minimum of 150 volts is used to trigger the thyratron although a potential as low as 50 volts will cause the tube to conduct. T-106 has high leakage reactance, and functions as a low-pass filter. This prevents high-voltage peaks of approximately 0.01-microsecond duration, produced at the V-104 grid at the time of ionization, from damaging the V-105 cathode insulation. The cutoff frequency of T-106 is sufficiently high, however, to reproduce the trigger pulse faithfully. As a further precaution against failure of the V-105 cathode insulation, the filament of that tube is floated at 100 volts above ground by resistors R-105 and R-138. Thus voltage differences between cathode and filament are held to a minimum.

The thyratron used is a hydrogen-filled triode developed specifically for line-type modulator switching applications. Conventional mercury-type thyratrons can be used for this purpose, but the hydrogen type has manifold advantages, as follows: (1) Hydrogen, owing to its high ion mobility, deionizes rapidly, allowing high repetition frequencies; (2) Bombardment of the cathode by hydrogen ions is not particularly harmful, thus permitting peak currents close to the saturation point; and (3) Tube operation is not affected by ambient temperature.

The constants of L-102 and the pulse-line charging capacitors are so chosen that charging occurs in an interval less than that existing between discharges of the thyratron.

When the thyratron is not conducting, the pulse-line charging capacitors are charged and remain charged until the thyratron fires. The sequence is then repeated. Should a charge be left on the capacitors when the equipment is shut down, it will slowly leak off through bleeder resistors R-106 and R-120.

Owing to the rectification action of the thyratron the usual problem of eliminating pulse tails no longer exists. (A spark gap conducts both ways, allowing pulse current to pass in either direction.) It is not necessary to employ thyrite for damping purposes with consequent loss in pulse power. The tail-damping choke has been eliminated by introducing an air-gap in the core of the magnetron pulse transformer. This air-gap reduces the shunt inductance just as the choke did on spark gap modulators. R-101 to R-104, connected across the primary of the pulse transformer, are commonly referred to as damping resistors, although their primary function is actually to dissipate the pulse energy when the magnetron load is accidentally removed. Were this provision omitted, Z-101 and T-108 would be subjected to extreme voltage peaks, resulting in insulation damage.

The blocking oscillator V-106 is relatively unaffected by changes in plate voltage. Any changes

in filament voltage, however, will cause serious drift in repetition frequency. V-108 is a current regulator which maintains constant current and hence constant filament voltage on V-106 over a wide range of line voltage.

Connected across the modulator output is the primary of transformer T-108, which provides low-potential pulses for synchronizing purposes. Transformer T-108 also supplies a positive trigger voltage for IFF operation.

5. TRANSMITTER.

a. GENERAL. — The Transmitter proper is composed of a magnetron oscillator and a fixed-tuned waveguide r.f. system. TR and ATR boxes are provided on the r.f. assembly. These act as electronic switches to connect either the Transmitter or the Receiver to the common waveguide transmission line at the desired instant.

A pulse transformer steps up the high voltage from the Modulator to the proper amplitude to operate the X-band magnetron. A sample of the outgoing pulse is delivered via a bridging attenuator to the a.f.c. circuits which automatically pretune the Receiver to the transmitted frequency.

Both the Transmitter and the Receiver are housed in a common case. The transmitter circuits are described below; the receiver circuits are described in Sec. IV.6.

b. PULSE TRANSFORMER. — The pulse-forming line in the Modulator is designed to operate into a 50-ohm load. This line generates a pulse of approximately 3 kv. which is delivered to the Transmitter through a 50-ohm coaxial cable. Pulse transformer T-301, which has a turns ratio of 4-to-1, matches the 50-ohm line to the 800-ohm magnetron and at the same time increases the pulse voltage to approximately 12 kv. (See Fig. 4-5.)

Two identical secondary windings are provided on the pulse transformer, and phasing is such that a negative pulse in the primary produces negative pulses of equal amplitude in each secondary. Both secondaries are thus brought up to the same potential, allowing filament transformer T-302 to be placed at the ground end of the pulse transformer windings. Heating the magnetron filament through the two pulse transformer windings permits the use of a filament transformer with relatively low-voltage insulation. Capacitor C-302 acts as a high-frequency by-pass, in effect connecting the secondary windings in parallel at the high frequencies comprising the square-wave pulse, but blocking the 60-cycle current. The pulse transformer case is oil-filled and provided with an expansion bellows on one side.

c. PULSE MODULATION. — In order to generate microwave energy, a potential difference must be developed across the magnetron cathode and anode (plate). The anode is connected to ground; the cathode is made negative by connection to the secondaries of the pulse transformer. Thus the anode remains positive with respect to the cathode during the period of the one-microsecond pulse.

The magnetron sends out trains of r.f. energy persisting for one microsecond and occurring approximately 465 times per second (at 2150-microsecond intervals).

In detail, the circuit functions as follows: The positive end of the pulse transformer secondary is connected to ground through capacitor C-303, which is shunted by a bank of resistors R-306 through R-313. Capacitor C-303 provides a low-impedance path to ground for the one-microsecond pulse, thus completing the current path through the pulse transformer secondaries and the magnetron. During the pulse, capacitor C-303 accumulates a small charge, which discharges through resistors R-306 through R-313 during the quiescent period of the pulse. This biases the magnetron cathode positive with respect to the plate, preventing oscillation on minor pulses ("tails") which follow the main pulse.

A d.c. milliammeter connected from pin jack J-305 to ground provides a relative indication of the average magnetron current, the normal indication being 3–6 ma. as measured on a 0–10 milliammeter. This pin jack is located on the top edge of the pulse transformer.

The r.f. output is taken from the magnetron by inductive coupling and is radiated into the waveguide by a small tip radiator.

Since the magnetron must dissipate considerable heat, a blower is provided for cooling.

d. OPERATION OF THE R.F. SYSTEM. — The r.f. assembly actually used is a pretuned section of waveguide (closed at one end) rigidly mounted in the Transmitter-Receiver Unit and coupled to the main waveguide run through a styramic window in the unit base. A coupling sleeve near the closed end forms, in conjunction with the anode lead, a short coaxial cable, coupling the magnetron to the r.f. assembly. The coupling device is a tip radiator (the end of the anode lead).

Along the r.f. assembly are located the TR box and the ATR box. The duplexing cavities are in

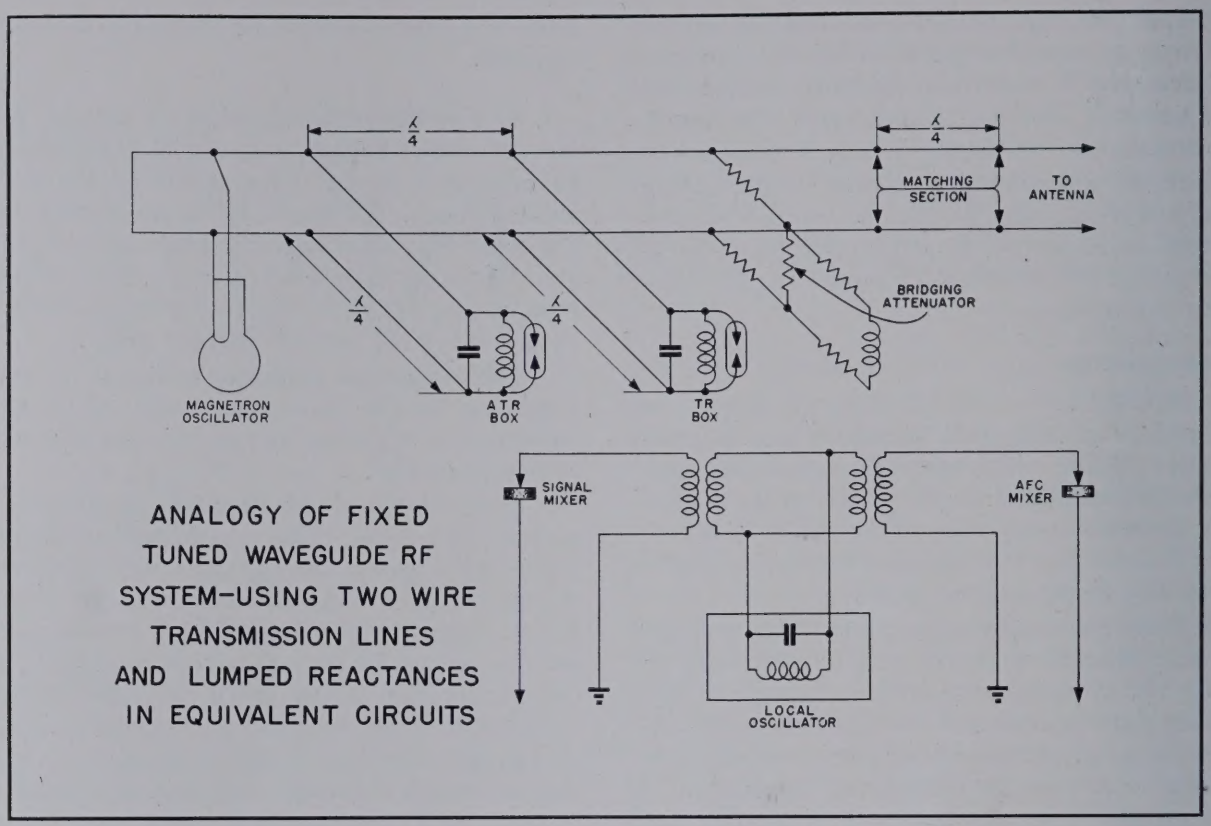


Figure 4-4

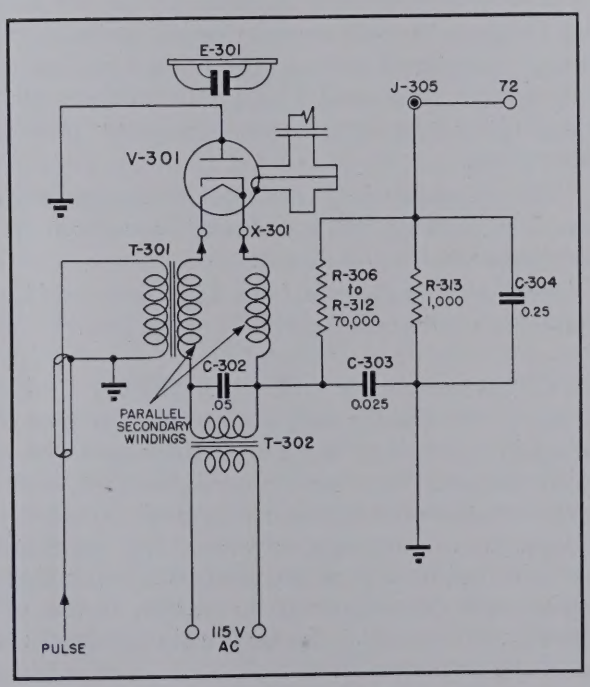


Figure 4-5—Pulse Transformer and Magnetron

effect an electronic switch connecting the waveguide to the Transmitter during transmission (at the same time isolating the Receiver from the waveguide), and connecting the waveguide to the Receiver during reception.

At the mixer input assembly is a protective shutter. This shutter is held open by a solenoid during operation of the equipment, but remains closed at all other times. This device prevents damage to the crystal mixer from excessive microwave energy from other near-by transmitters when the equipment is idle. During operation of the equipment the crystal is protected by the TR box.

The r.f. assembly is coupled to the waveguide run through matching sections RF-302 and RF-303 mounted near the bottom of the unit case. This coupler contains the necessary iris and choke to provide efficient transfer of energy from the r.f. assembly through the styramic window RF-304 to the main waveguide run.

Functionally the r.f. system operates as follows: During transmission, energy is conducted from the magnetron by a short coaxial line and is radiated from the tip into the waveguide. The dimensions and positions of the radiator and wave-

guide plug are such that the coupling coaxial line is properly terminated, and maximum energy is transferred from the magnetron to the waveguide.

As the energy travels up the r.f. assembly, a small portion of it passes through the slot in the edge of the waveguide and enters the TR box and ATR box. Since the cavities are tuned to the frequency of the Transmitter, maximum voltage appears across them. Connected across the cavities are gaseous duplexing tubes which ionize when the cavities are excited. This action virtually short-circuits the cavities. As the receiver mixer is coupled to one cavity, the amount of energy entering the mixer is limited to a safe value. To facilitate rapid ionization a keep-alive electrode is provided in the TR box. This electrode is energized from a high-voltage secondary of transformer T-303, thus keeping the tube in partial ionization at all times.

During transmission the duplexing cavities limit the energy entering them without altering the characteristics of the waveguide. After passing the cavities, the microwave energy passes through the coupling choke, enters the main waveguide run, and is finally radiated by the Antenna.

During reception, the ATR box deionizes and in effect closes the waveguide below its coupling slot. The TR box also deionizes and provides maximum coupling into the mixer. As the echoes return from the targets they pass down the waveguide through the coupling choke, and into the duplexing cavity. Since the mixer is coupled to the TR box, almost all the returned energy enters the Receiver. (The theory is discussed below.)

e. THEORY OF THE R.F. SYSTEM. — A low-frequency analogy of the r.f. system is shown in Fig 4-4. In this analogy, the waveguide appears as a two-wire balanced line. The duplexing cavities are shown as parallel-resonant circuits and the duplexing tubes as spark gaps. The waveguide mixers are shown as circuits coupled with a crystal. The attenuator shown is actually a small iris in the waveguide coupling between the main waveguide and the a.f.c. mixer.

During transmission, energy flows out of the magnetron and up the line. The anti-TR tube fires, shunting a high impedance across the line a quarter wavelength away. This high impedance does not affect the transmission line characteristic. As energy flows on up the line, the TR tube also fires with the same result; and since the TR tube virtually short-circuits the receiver input, very little energy from the transmitted pulse enters the Receiver.

Farther up the line, a high-impedance attenuator is bridged across the line. Since the input impedance of the attenuator is high, the characteristics of the line are unchanged, and only a small amount of energy enters the network. The energy coming out of the attenuator is reduced to a low enough level to operate the mixer safely.

To return to a consideration of the transmission line, the energy then continues up the line and through the quarter-wave impedance-inverting section which matches the impedance inside the transmitter case to the external line impedance. The energy then continues to its terminating load provided by the Antenna. The Antenna appears to the line as a pure resistance that matches the surge impedance of the line; thus the transmission line is flat and has a very low standing-wave ratio.

At the end of the transmitted pulse, the duplexing tubes "go out" and unblock the receiver input. As echoes return down the line, they first encounter the attenuator. A very small portion of the echo enters the attenuator but emerges at the output too weak to operate the a.f.c. circuits; thus echoes and signals from other nearby Radars have negligible effect on the receiver tuning.

As the echoes reach the TR cavity, almost all of the echo energy enters it, since the cavity reflects across the line an impedance which is very close to the surge impedance of the line. The ATR box has a much higher Q than the TR and reflects a short circuit across the line a quarter wavelength below the TR box. Any echo energy that does not enter the TR is reflected at the ATR back to the TR. Energy reaching the TR passes through the mixer and into the Receiver. If the local oscillator frequency is correct, normal superheterodyne reception results.

6. RECEIVER.

a. GENERAL. — The SO-4 Receiver may be operated either with manual tuning (as a conventional Radar superheterodyne) or with automatic tuning. The automatic frequency control (a.f.c.) circuit is included to offset the inherently greater frequency drift and instability of X-band oscillators. The use of a.f.c. eliminates the necessity of frequent manual retuning during a single operating period.

The Receiver includes a local oscillator, two mixers, eight conventional i.f. stages, one i.f. stage for the a.f.c. strip, a diode detector for the regular i.f. strip, a diode discriminator for the a.f.c. strip, a video amplifier for the signals, a video amplifier for the a.f.c. video pulses, a 2050 gas tetrode control

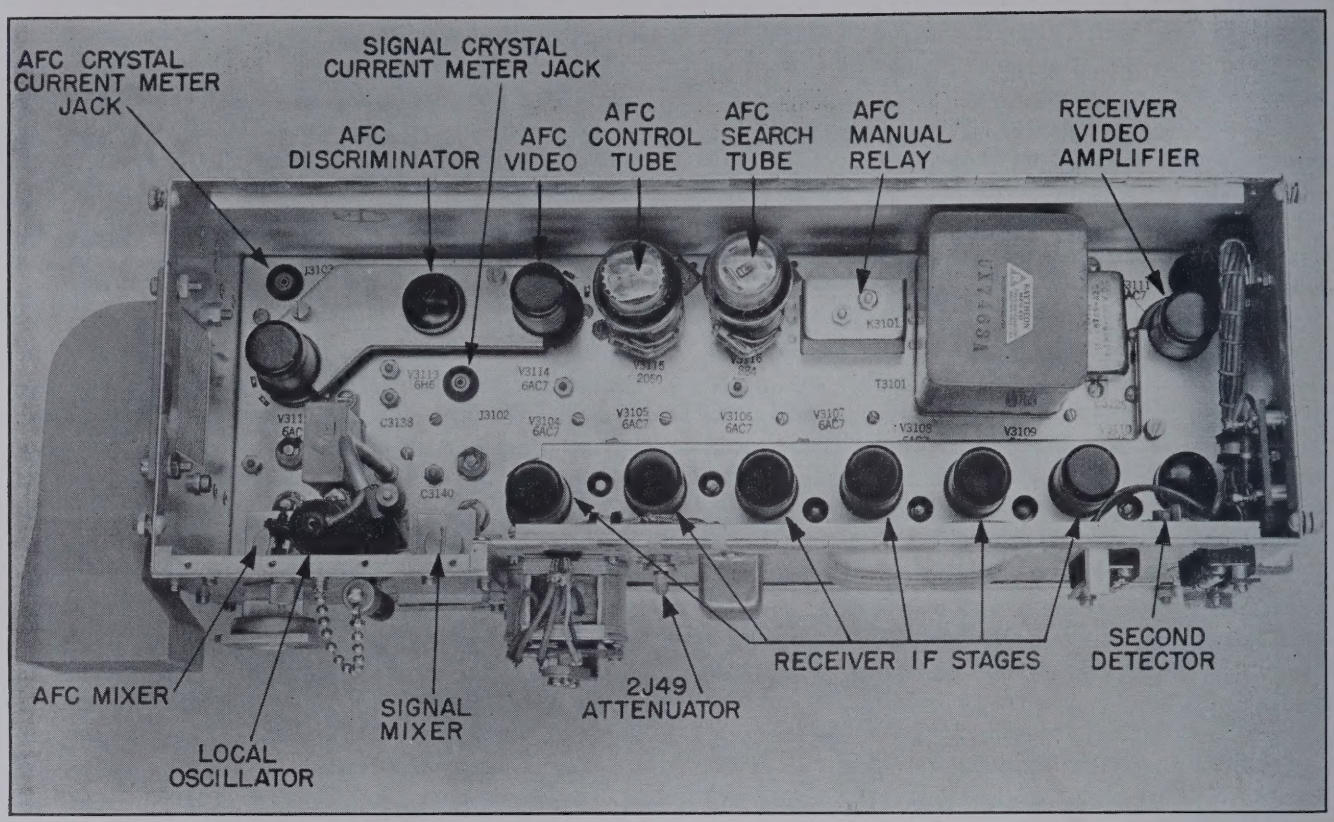


Figure 4-6—Receiver Unit: Top View with Cover Removed

tube and an 884 gas-triode saw-tooth oscillator for the a.f.c. system, and a relay for switching from a.f.c. to manual tuning. The Receiver also has a waveguide r.f. section including the two mixer assemblies and a shutter solenoid; and a second waveguide section coupling to the magnetron and regular waveguide run, and housing the TR and ATR boxes.

The receiver tubes are: local oscillator, 723A; i.f. amplifiers, 6AC7; diode rectifiers, 6H6; TR tube assembly, 1B24; and ATR tube, 724A. The mixer crystals are type 1N23.

The i.f. strip is of conventional design and has a gain of approximately 120 db and a bandwidth of 2 Mc. The input to the i.f. strip employs broad-band coupling and is driven from a waveguide-type crystal mixer.

b. LOCAL OSCILLATOR. — The local oscillator beats against both the signal mixer and the a.f.c. mixer, and therefore generates the same intermediate frequency in both strips. When operating on manual tuning, the Receiver functions just as in SO-a/SO-13 systems, except that the polarity of the video output is negative instead of positive. When operating on a.f.c., the Receiver functions as with manual tuning, except that automatic control of local oscillator tuning is added.

The local oscillator (velocity-variation type) employs a resonant cavity as the basic frequency-controlling device. The electron stream is directed by the repeller plate through the cavity and then reflected back again in phase so as to sustain oscillation. This reflex-klystron action is the same as that of the 707A-B used in SO-a/SO-13 Receivers. The X-band local oscillator is a smaller tube — a so-called Shepherd rather than McNally type. Broad tuning is done mechanically as with the McNally tube, in this case by distorting the cavity vertically instead of horizontally. The oscillation frequency can be varied electrically over a band of about 100 Mc. by varying the repeller voltage over a moderate range.

The peak signal output is limited by the video stage to approximately 1 volt, as in the SO-13 Receiver.

c. AUTOMATIC FREQUENCY CONTROL CIRCUIT. — The tuning (frequency) of the receiver local oscillator is automatically controlled

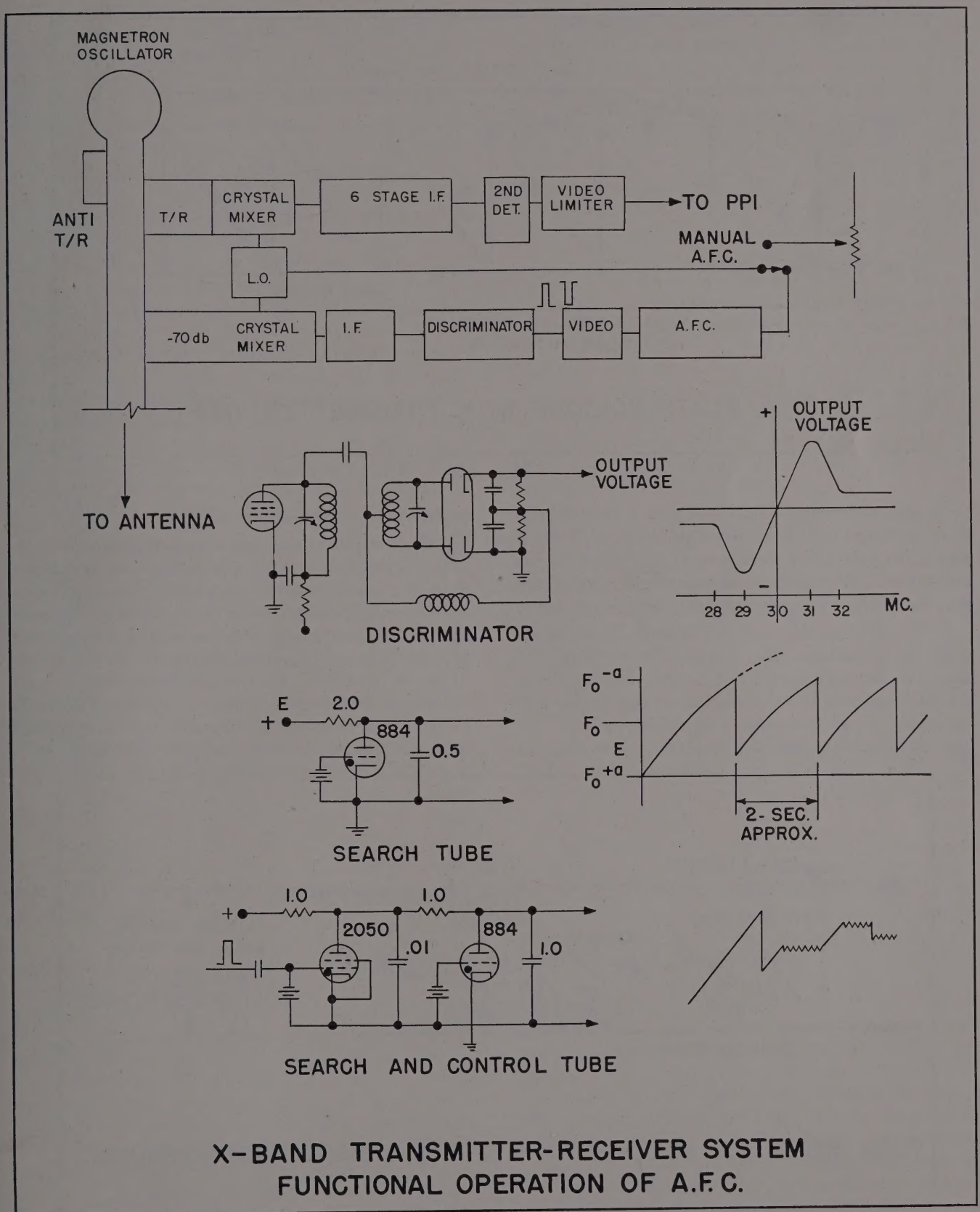


Figure 4-7—Functional Operation of Receiver A. F. C. Circuits

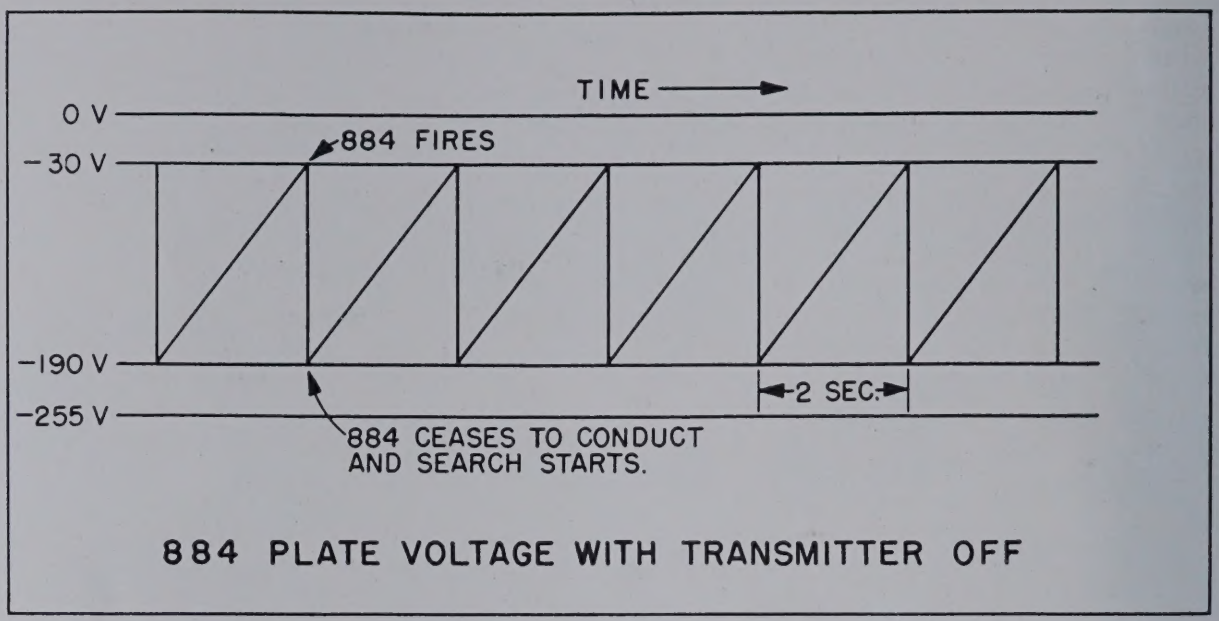


Figure 4-8

by a special circuit. The circuit is a closed loop from the local oscillator through the a.f.c. system and back to the local oscillator. It comprises a separate mixer, i.f. amplifier, frequency-sensitive detector, video amplifier, control tube, and search tube.

The local oscillator beats against both the receiver mixer and the a.f.c. mixer. The output of the latter is the beat between a sample of the transmitted frequency and the local oscillator frequency; for correct receiver tuning it should be 30 Mc. This beat is amplified and applied to the frequency-sensitive detector (discriminator).

The output of the discriminator is *positive* half-cycles when the applied i.f. is *higher* in frequency than its zero output (mid-frequency) frequency, and is *negative* half-cycles when the applied i.f. is *lower* than its mid-frequency. The output is zero when the applied frequency and mid-frequency are the same. (This is standard discriminator performance as encountered in regular f.m. receivers.) The mid-frequency is adjusted to coincide *exactly* with the center of the receiver i.f. bandpass (30 Mc.).

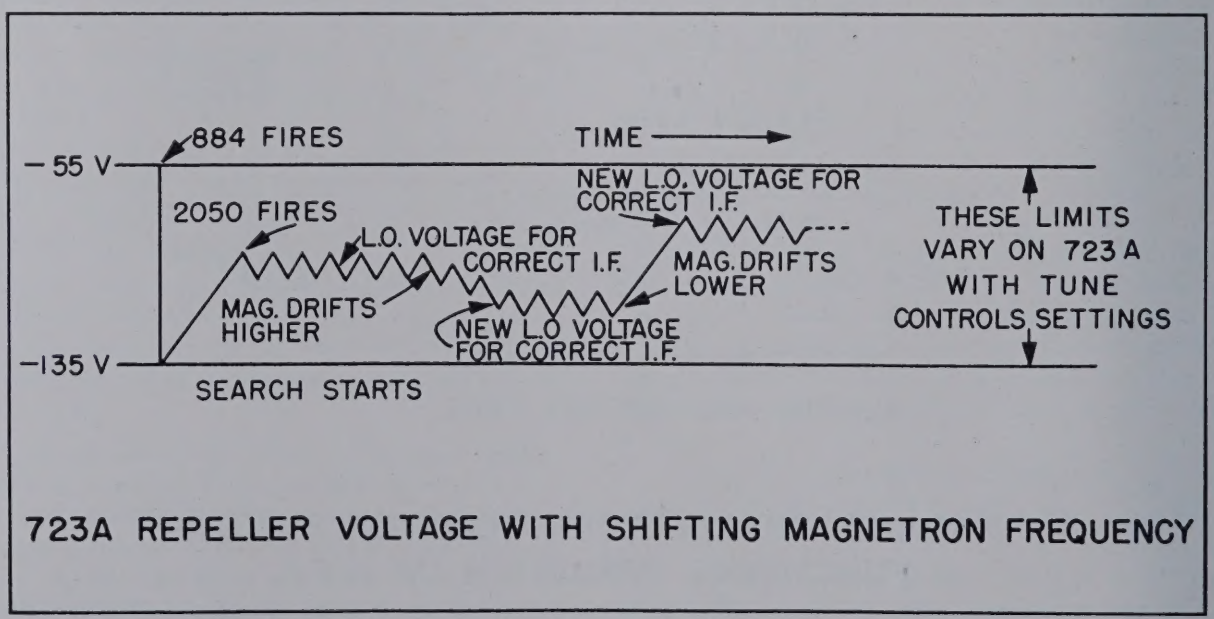


Figure 4-9

The output of the discriminator is filtered and applied to a video amplifier in the form of positive or negative one-microsecond pulses. The pulses are amplified, inverted, and applied to the grid of the 2050 gas-tetrode control tube.

The control tube is biased sufficiently so that it will not conduct until a positive trigger is applied to its grid. It then conducts until capacitor C-3136 (connected between its plate and cathode) is discharged. This permits capacitor C-3138 (in the plate circuit of the search tube) to charge for the same period of time. When the control tube ceases to conduct, C-3136 begins to charge and C-3138 begins to discharge. Since C-3136 has a short time constant (0.01 second) and C-3138 has a long time constant (2.0 seconds), C-3136 can charge and discharge while the voltage across C-3138 varies very slightly. Consequently, the control tube can function to vary the voltage on C-3138 (and also on the local oscillator repeller plate) over a very narrow range. This in turn adjusts the local oscillator tuning over a small frequency range of about 0.1 Mc.

Any variations in local oscillator frequency will change the frequency applied to the a.f.c. discriminator. This in turn will cause either positive or negative pulses (or zero voltage) to appear at the control tube grid. The polarity of the system is such that if the i.f. generated is *greater* than 30 Mc., the local oscillator repeller voltage is made *less* negative (reduced) and the frequency of the local oscillator is *lowered*. If the i.f. generated is *less* than 30 Mc., the local oscillator voltage is made *more* negative (increased) and the local oscillator frequency is *raised*.

In order for this action to shift the local oscillator towards the correct i.f. of 30 Mc., the local oscillator must be set higher in frequency than the magnetron. The local oscillator, through the action of the a.f.c. circuit, will then hold itself at 30 Mc. above the magnetron frequency.

Since the control tube cannot shift the local oscillator over a wide range of frequency at the proper rate, a search tube (884 gas triode) is also provided. This tube, when *not* controlled by the 2050, produces a saw-tooth voltage cycle every 2 seconds. When the search tube fires, it charges C-3138 to approximately 200 volts negative. When the tube is idle, C-3138 discharges through the 2-megohm resistance into B+ 105 volts, and through the 4-megohm resistance into the Tune and Tune Set potentiometers. Thus the voltage appearing at the plate of the local oscillator lies midway between the voltage at the arm of the Tune potentiometer and the voltage on C-3138.

The consequent change in local oscillator frequency during this period (the total sweep of the 884) may be as great as 100 Mc. — a range which covers the spectrum around the magnetron frequency well beyond the intermediate frequency in both directions. Consequently, the proper intermediate frequency is generated at some instant during the 2-second period, provided that the cavity tuning is correct. When this occurs, the 2050 takes control and normal a.f.c. operation is established.

To summarize: with the Transmitter running and the a.f.c. properly adjusted, the local oscillator is tuned by each transmitted pulse which occurs when the local oscillator is very slightly off-tune on the low-frequency side. The local oscillator is alternately corrected by the search circuit when it is off-tune on the high-frequency side. These opposing corrective actions keep the local oscillator frequency confined within a very narrow region centered at the frequency to which the discriminator transformer is tuned for zero output.

Because of the high-attenuation coupling from the waveguide to the a.f.c. mixer, no reflected echoes or interfering signals are strong enough to affect the a.f.c. system, and thus only the main pulse of the transmitter supplies the frequency which tunes the Receiver.

Since the a.f.c. is driven by a sample of the one-microsecond transmitted pulse, this circuit will not function when the Transmitter is *not* being pulsed, and the 884 search tube will then swing the local oscillator back and forth over its total tuning range. Under such conditions, the crystal current will vary between minimum and maximum value at two-second intervals.

Because the possible frequency swing is so great, initial tuning *must* be done carefully to make sure that the local oscillator cavity is tuned to the *high* side of the transmitter frequency; as otherwise the repeller voltage required to raise the local oscillator to a high enough frequency will be greater than optimum value, and the possible range of correction through the a.f.c. system will be lowered by 60 Mc. Operation may accidentally occur on the low-frequency side when using manual tuning and on the high side when using a.f.c. Either condition will result in improper crystal currents on either a.f.c. or manual tuning. I.e., if the a.f.c. is correct, it will result in low crystal current and impaired sensitivity on manual tuning; while if manual is correct, this will result in dangerously high crystal current on a.f.c. When the cavity tuning is on the high-frequency side and both a.f.c. and manual

tuning are on the same side, equal performance will result with either a.f.c. or manual tuning, and crystal currents will be the same for both.

As the intermediate frequency for both the Receiver and the a.f.c. is automatically locked at the center frequency of the discriminator, this center frequency must be precisely aligned with the center of the i.f. bandwidth (nominally 30 Mc.). Alignment is accomplished fairly quickly and very accurately by means of a synchronized scope and a signal generator modulated 5 or 10 Mc. around the 30-Mc. point. The signal generator must have an electronic mark at its sweep-frequency center or a movable mark whose frequency is indicated. A regular 30-Mc. generator and vacuum-tube voltmeter or similar indicator (such as an unsynchronized scope) can be used but the alignment operation will be more tedious.

d. INPUT CIRCUITS AND CRYSTAL MIXERS. — The input assembly of the Receiver is composed of a square U-shaped waveguide assembly. It is coupled to the r.f. system through the TR box and the a.f.c. attenuator bushing.

Each side section of the assembly feeds a separate crystal which is connected across the static field in the closed end sections of the guide so as to pass r.f. but block d.c. The distance of each crystal from the closed ends is adjusted to match the impedance of the field at that point. The rectified output is fed through the primaries of the i.f. input transformers and inductively coupled to the input grids of their respective i.f. channels.

Interconnecting the two side sections is a third piece of waveguide on which is mounted the local oscillator. The local oscillator is coupled into this section by a radiation probe on the end of its output coaxial line. The intermediate section is in turn coupled to the mixer sections by small iris openings at each end. The degree of coupling is individually adjusted by two machine screws projecting into the iris openings. R.F. leakage around the coupling screws is prevented by an air gap and choke built into the outer housing of the coupling. Thus r.f. coupling is established to a common local oscillator, and high attenuation from one mixer to the other is provided by the two iris openings and the intermediate waveguide section.

A slot is provided for the insertion of a load resistance into the field of the interconnecting section of the guide for use in case it is necessary to lower the standing-wave ratio. Such a load would consist of a very thin coating of resistance material on an insulating square, and its resistance would be approximately 600 ohms.

When the equipment is secured and the TR box is inoperative, the receiver mixer crystal is liable to

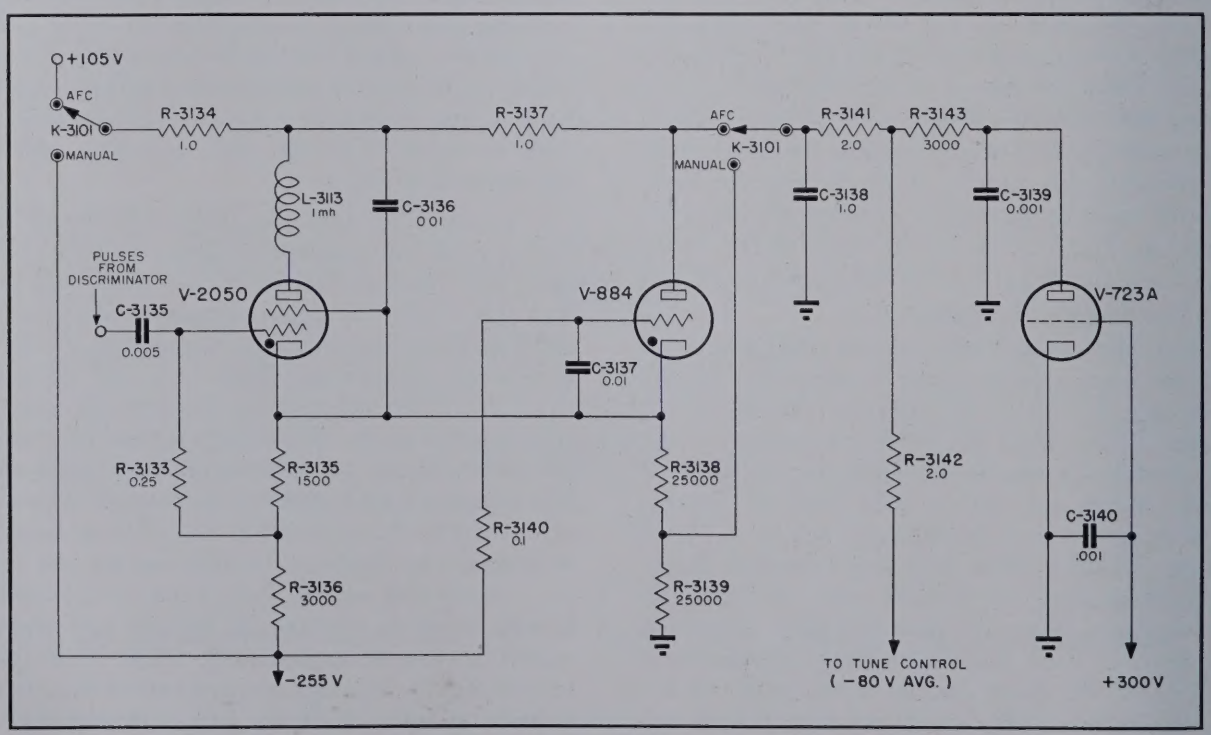


Figure 4-10—Search Control Tube and Local Oscillator

damage from r.f. energy from nearby transmitters. To prevent such damage, a shutter is provided in the space between the TR box and the input assembly to the receiver mixer. The shutter is held open by a rotary solenoid when the equipment is on, and is closed by a spring when the equipment is secured.

e. INTERMEDIATE – FREQUENCY AMPLIFIER. — This section of the Receiver consists of six stages of amplification operating on a frequency of 30 Mc. The gain per stage is approximately 20 db. Circuit constants and performances are practically identical in each stage. Gain is controlled by varying the grid voltage of the second and third stages.

The stages are impedance-coupled, and the tube and circuit capacitances are combined with adjustable inductances to form resonant circuits. The plate voltage is applied through a low resistance which loads the resonant circuits and gives the necessary broad band pass characteristic.

To eliminate regeneration throughout the amplifier, filtering is provided in the power and filament leads of each stage. Isolating resistors are used in the power leads, and by-pass capacitors in the filament leads. To prevent interference from the Transmitter from entering the i.f. amplifier, the separate leads are filtered at the entrance points.

f. DEMODULATOR AND VIDEO-LIMITER. — The demodulator tube is connected as a diode, the plate load circuit being filtered by a small inductor and capacitor to prevent 30-Mc. energy from entering the video-limiter stage. The demodulator develops across the diode load resistor a negative pulse output which is capacitively coupled to the video-limiter.

The video-limiter is operated at near zero bias, and the plate current is limited to less than 10 ma. by reducing the screen voltage through a dropping resistor. The output cable of the Receiver terminates at the Indicator in a load of 100 ohms, which is the cathode resistor of the video-limiter stage.

Any pulse applied to the video-limiter grid of sufficient amplitude to drive the limiter to plate current cutoff will be reproduced as a negative signal of one volt across the 100-ohm limiter output circuit. Pulses of greater amplitude than this cannot produce an output greater than one volt, as the tube cuts off at one volt. Thus the limiting of strong signals results in a lower PPI brilliance ratio between weak and strong signals.

7. INDICATOR.

a. GENERAL. — The Plan Position Indicator (commonly called the Indicator) houses the PPI tube with its associated deflection coil drive mechanism, bearing dial, and video and sweep circuits. It also contains the principal operating controls, which are fully described in Sec. III. A front view of the unit is shown in Fig. 3-1.

The screen of the PPI tube presents a map-like view of targets (reflecting objects) on the surface of the water surrounding the ship within range of the equipment. Targets appear as light streaks at right angles to a radius of the PPI. These streaks remain visible through the action of the long-persistence phosphorescent screen after the radial sweep has passed, thus permitting range and bearing to be read.

Each time the radial sweep comes around to a target point it retraces the target, and movement of the target is indicated in successive sweeps. Aircraft are easily identified in this manner. The experienced Radar operator can quickly determine the general nature of a target appearing on the PPI.

The functional operation of the Indicator is described below:

A negative pulse taken from the Modulator triggers the square-wave multivibrator. The multivibrator furnishes: (a) negative square waves for keying the marker oscillator; (b) negative square waves for keying the sweep generator; and (c) positive square waves for unblanking the PPI tube. Since these square waves are simultaneously applied to their respective circuits, synchronization of the first marker, the sweep start, and the PPI unblanking is accomplished. These three operations are also synchronized with the transmitted pulse.

The output of the marker oscillator appears as damped wave trains recurring at the repetition rate. These are amplified, flattened, and shaped into sharp negative pulses (pips) in succeeding stages. These pips are applied through the Marks Control to the cathode of the PPI tube and appear as well-defined dots equally spaced over the radial sweep.

As the sweep rotates, the markers trace concentric circles on the screen. These circles are spaced at intervals representing 1, 5, or 20 miles, depending upon the position of the Range Switch. The markers may be varied in intensity or removed from the screen by adjustment of the Marks Control.

Since the PPI tube employs magnetic deflection, the output of the sweep generator amplifier is a sawtooth current. This current, when passed through the deflection coil, produces the desired linear sweep. The sweep coil is mounted in a rotatable yoke and is rotated in synchronism with the An-

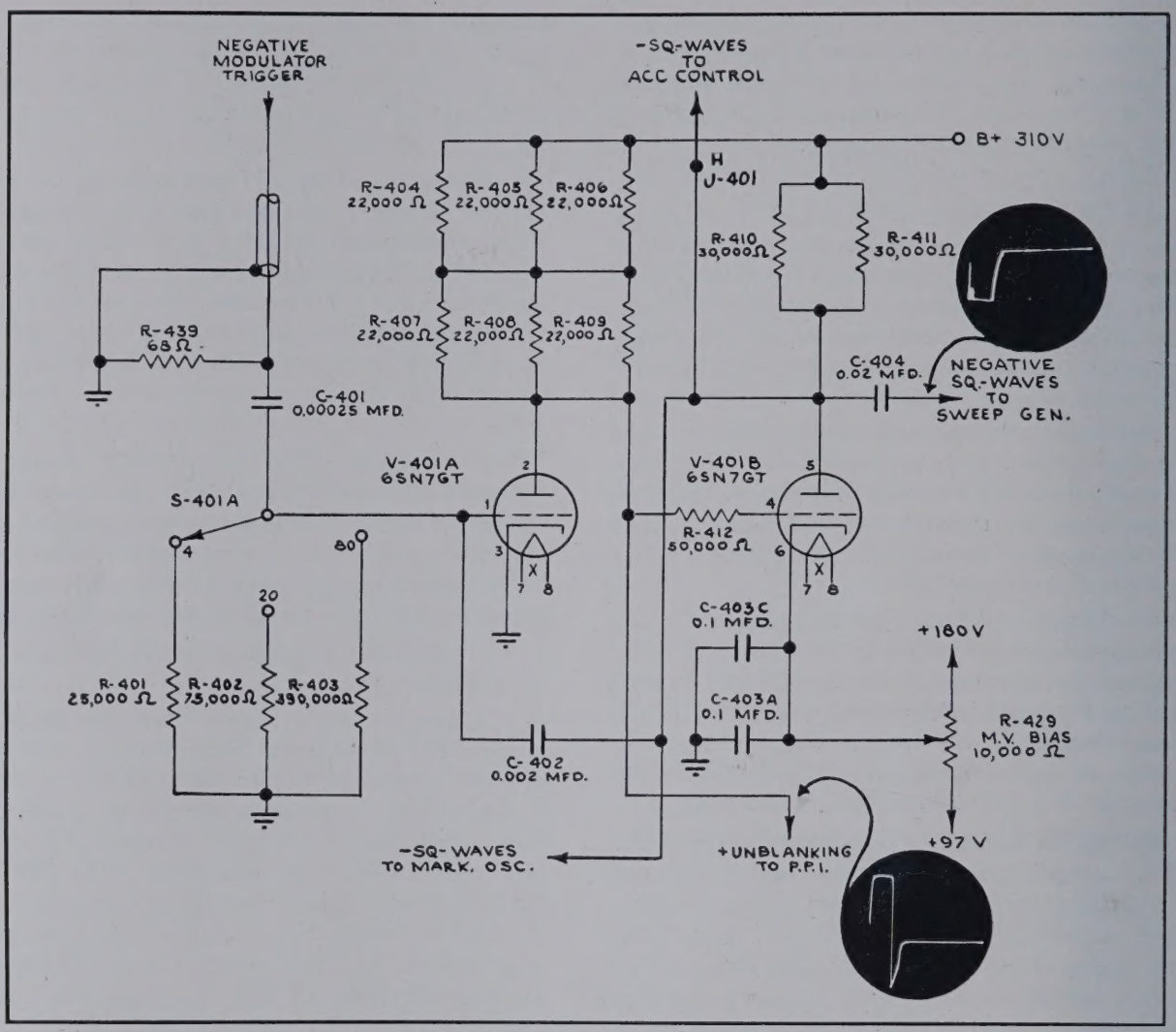


Figure 4-11—Plan Position Indicator: Square-Wave Multivibrator (Synchroscope Waveforms)

tenna by means of a synchro system. Bearing information is thus transmitted from the Antenna to the PPI.

The PPI tube is normally biased so that the electron stream is cut off and the screen is blanked. During the outward travel of the sweep the screen is unblanked by a positive square wave; during the return travel of the sweep the screen remains blanked, thus preventing the appearance of undesirable return traces.

Signals in the form of video pulses are delivered from the Receiver to the video amplifier in the Indicator. The output of this amplifier is applied to the PPI tube, where it causes instantaneous intensification, thereby placing a spot on the screen. The distance of this spot from the screen center corresponds to the range of the target. When the bearing cursor is rotated until it bisects the target, bearings may be read from the bearing dial surrounding the PPI. Approximate range calculations may be made with the aid of the range marks on the screen (see Fig. 3-3).

b. SQUARE-WAVE MULTIVIBRATOR.—The square-wave multivibrator (V-401A and B) is the nerve center of the Indicator. It generates square waves of approximately 48, 244, and 976 microseconds duration for 4, 20, and 80 mile ranges respectively. In each case the start of the square wave is synchronized with the transmitted pulse. Each of these three pulse durations is slightly longer than the indicated values, thus permitting the sweep rate to be reduced by adjustment of the Sweep Length Control, and permitting targets to be viewed a short distance beyond the fifth marker.

The multivibrator operates as follows: Section A of V-401 operates with zero bias and normally

conducts. Section B of the same tube is biased beyond the plate cutoff point. These triodes may be regarded as switches which alternately open and close. Normally section A is closed and section B is open, with the plate of section A near zero potential with respect to ground and with the plate potential of section B at about +300 volts. (See Fig. 4-11.)

To consider one cycle of operation: a negative trigger pulse from the Modulator is applied to the grid of section A (V-401), cutting off its plate current. The plate voltage of section A immediately jumps to nearly +300 volts, applying a positive voltage to the grid of section B and allowing plate current to flow in this section.

When current begins to flow in section B, its plate immediately drops to a potential nearly equal to its cathode voltage. Capacitor C-402 is thus left with a charge received when the plate of section B was at +300 volts. The capacitor now discharges exponentially through R-401 (4-mile range), producing a negative voltage drop which locks the multivibrator until the drop across R-401 becomes low enough to allow section A again to draw plate current.

When this occurs, the plate potential of section A is suddenly lowered, reducing the positive grid voltage in section B and allowing its plate current to be cut off. The plate potential of section B then increases suddenly to +300 volts, recharging capacitor C-402. This action produces a positive drop across R-401, causing this resistor to draw slightly more current than normally. This in turn causes the plate potential of section A to go slightly nearer zero and to return to its normal quiescent value. The result is a low-amplitude negative "kick" at the end of the positive wave. No "kick" is present on the negative wave.

As previously explained, the plate potential of section A starts from near zero, suddenly increases to +300 volts, holds this potential for the duration of the square wave, then suddenly reduces to its starting potential. In section B, the plate potential starts from +300 volts, suddenly reduces to a lower value (the cathode voltage of section B), maintains this potential for the duration of the square wave, then suddenly increases to +300 volts.

Thus positive square waves are taken from the plate of section A and negative square waves are taken from the plate of section B.

The duration of the wave is determined by the time constant of the circuit composed of R-401 (or R-402 or R-403) and C-402. A switch selects the resistor for the desired range.

c. VIDEO AMPLIFIER. — The video amplifier is a conventional two-stage resistance-coupled channel. A low-amplitude negative pulse from the Receiver is applied to the cathode of the first stage (V-406A), where it is amplified and then applied to the control grid of V-406B. The output of this stage is a positive pulse of sufficient amplitude to produce unblanking (illumination) when applied to the #1 grid of the PPI tube. Series inductor L-407 in the amplifier output circuit improves the frequency response by counteracting stray output capacitances. A comparatively wide frequency-response band is

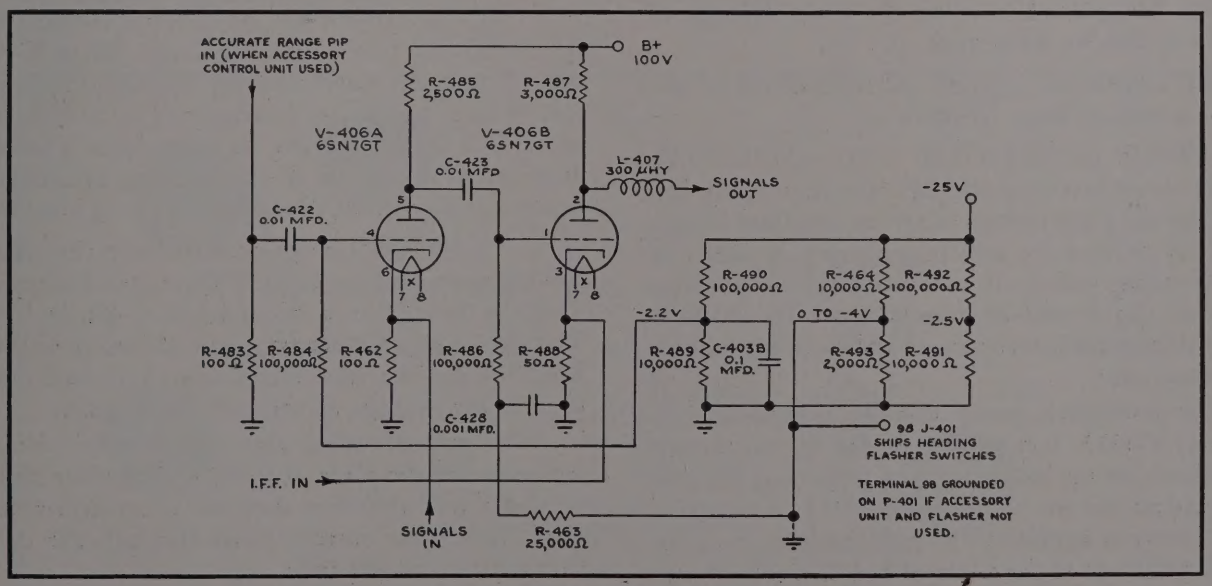


Figure 4-12—Plan Position Indicator: Video Amplifier

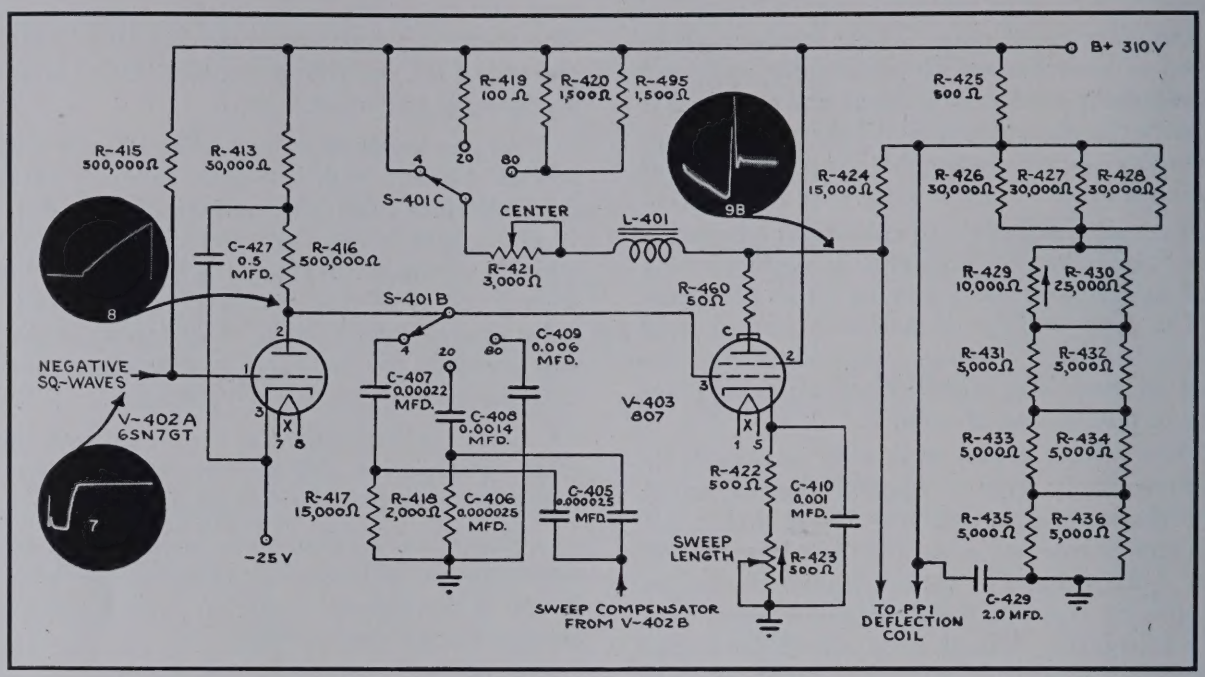


Figure 4-13—Plan Position Indicator: Sweep Generator and Amplifier (Synchroscope Waveforms)

provided to pass the high-frequency components of the pulse, thus preventing distortion of the waveform.

A second video input is provided at the grid of V-406A. This input takes positive signals supplied by the A.C.U. to produce the movable range mark.

The grid return circuit of V-406B is tapped and brought out to terminal 98 on P-401. This circuit produces the ship heading flash on the PPI. A cam micro-switch in the Antenna momentarily opens the bias bus ground, causing the plate voltage of V-406B to rise for an instant.

IFF signals are applied to the cathode of the second amplifier stage (V-406B).

d. SWEEP GENERATOR AND AMPLIFIER. — The radial sweep of the PPI is magnetically operated by the plate current of sweep amplifier V-403, which is excited by sweep generator V-402A. A compensating circuit is used to improve the linearity of the 4- and 20-mile sweeps. The 80-mile sweep is inherently more linear and does not require compensation.

The saw-tooth sweep voltage is generated as follows: V-402A is normally biased to saturation, its cathode being biased to −25 volts and its grid being connected to +B through R-415. A negative square wave is applied to its grid, causing it to cut off. The voltage at the plate of V-402A, which was at approximately ground potential, then rises exponentially as capacitor C-407, C-408, or C-409 (depending on the range selected) charges through R-416. The value of each capacitor is such that the voltage at the plate of V-402A rises to about 110 volts before the square wave ends, at which time V-402A again conducts, dropping its plate potential to near zero.

Two methods are used on the two shorter ranges for improving the linearity of the voltage rise at the plate of V-402A:

(1) Resistor R-417 or R-418 is connected in series with capacitor C-407 or C-408. When V-402A cuts off, current starts flowing through the capacitor, which begins to increase its potential from zero. This initial current flow produces a voltage drop across R-417 or R-418, causing an instantaneous initial voltage rise at the plate of V-402A.

(2) A positive square wave from the plate of V-402B is applied to the high-voltage end of resistor R-417 or R-418 through capacitor C-406 or C-405. This produces a momentary flow of current through R-417 or R-418, thus causing an additional initial kick in the voltage at the plate of V-402A.

The grid of sweep amplifier V-403 is directly connected to the plate of V-402A. The plate current of V-403 will therefore increase as its grid voltage rises. This plate current flows through the deflection coil of the PPI tube.

Potentiometer R-423 (Sweep Length Control)

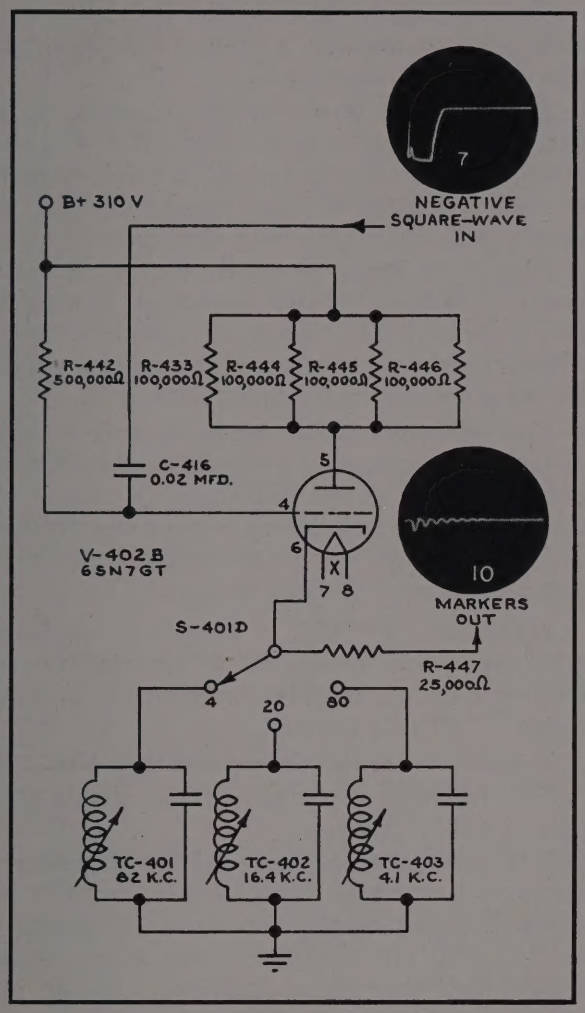


Figure 4-14—Plan Position Indicator: Marker Oscillator (Synchroscope Waveforms)

adjusts the length of the sweep by controlling the bias of V-403, thereby varying the gain. Potentiometer R-421 (Center Control) adjusts the centering of the sweep start by controlling the steady current flowing through choke L-401, the deflection coil, and through the voltage divider (resistors R-426 through R-436) to ground. Section C of S-401 (Range Switch) compensates for changes in centering when switching from one range to another.

e. MARKER OSCILLATOR. — The marker oscillator is a shock-excited, tube-keyed L-C circuit. The oscillation frequency is practically independent of tube characteristics, being mainly determined by the value of inductance and capacitance in the circuit.

Clamping tube V-402B normally operates with a moderate plate current flow. Energy is stored in the L-C circuit connected between cathode and ground of V-402B. When the negative pulse from the multivibrator is fed to the grid of the clamping tube, the resulting increased negative voltage causes the flow of plate current suddenly to stop. This allows the L-C circuit to oscillate at its natural period and to generate the series of damped oscillations. Only the first four or five cycles of the wave train are used during each receiving period. Although damped, the amplitude of these is still great enough to be usable.

Three tuned circuits are provided, delivering damped wave trains of 2-, 10-, and 40-mile wavelengths for the generation of 1-, 5-, or 20-mile markers respectively. Switch S-401D automatically selects the proper tuned circuit as the range is changed.

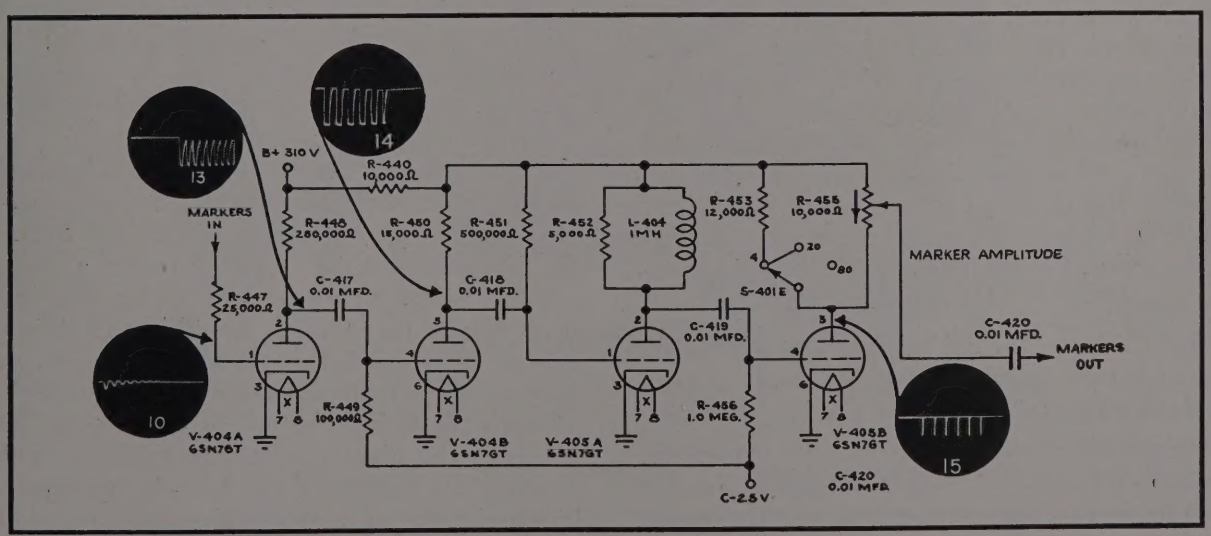


Figure 4-15—Plan Position Indicator: Marker Amplifiers and Sharpeners (Synchroscope Waveforms)

f. MARKER AMPLIFIERS AND SHARPENERS. — The grid of the first marker amplifier V-404A is directly coupled through a series resistor to the oscillating circuit. The excitation to this stage is flattened on positive peaks, owing to the flow of the grid current on the positive half-cycles. The output of this stage is a series of uniform flattened positive peaks and fairly uniform negative pulses. These are applied to the grid of the second marker amplifier V-404B. (See Fig. 4-15.)

The plate current of the second marker amplifier is normally cut off so as to prevent the generation of any positive pulses in the plate circuit. The output of this stage is a series of negative square-wave pulses of uniform amplitude. These pulses are applied to the grid of the third marker amplifier V-405A.

The third marker amplifier normally operates with a small positive bias. Its plate load consists essentially of a small inductance in parallel with a resistance. Only negative pulses are applied to the grid of this tube. This excitation causes small sharp peaks to occur across the plate inductance at intervals corresponding to the rise and fall of the square-wave excitation. These sharp positive and negative pulses are applied to the grid of the final marker amplifier V-405B.

The final marker amplifier is normally biased to cut off its plate current. Since its plate load is resistive, no positive peaks can appear at the output of this stage. The small, sharp, positive peaks of excitation generate high-amplitude sharp negative peaks at the output of V-405B. The plate load of this tube consists of potentiometer R-455 (Marks Control), and any desired portion of these negative pulses can be applied through this control to the cathode of the PPI tube. These negative pulses reduce the positive bias on the PPI cathode, thereby instantaneously increasing the intensity of the trace. This momentary brightening effect causes small bright spots to appear along the sweep trace at intervals corresponding to calibrated distances. When the sweep is rotating, these spots (range marks) appear as concentric circles, providing persistent range markers on the screen.

g. PPI TUBE.— The PPI tube is a type 5FP7 5-in. cathode-ray tube having a long-persistence screen. It employs magnetic focusing and beam deflection.

The positive pulse output of the video amplifier is applied to grid #1. Negative marker pips are applied to the cathode and appear as equally spaced spots along the radial sweep on the screen.

The rotating sweep-coil yoke is driven from a synchro motor through a 10-to-1 reduction gear train. (For details see page 4-25).

Potentiometer R-468 (Focus Control) varies the current through the focusing coil L-405, thus controlling the intensity of its coaxial magnetic field. Potentiometer R-459 (Intensity Control) adjusts the positive cathode bias, thus controlling the intensity of the trace. Normally the tube is biased beyond cutoff so as to blank the screen. During the time of the outward sweep only, positive square waves from the multivibrator are applied to grid #2 so as to unblank the screen momentarily.

The PPI tube with its sweep-coil rotating mechanism is mounted in a separate removable subassembly known as the PPI assembly. Since this subassembly must be removed in replacing the tube, replacement should not be attempted before reading the instructions outlined on page 5-17.

h. POWER SUPPLIES. — The power supply and filter combination for the PPI tube is included in the Indicator Unit. A separate transformer furnishes voltage for all tube heaters.

A half-wave supply, using one type 3B24 tube (V-408), furnishes 7-kv. d.c. for the accelerating anode of the PPI tube.

A full-wave supply (in the Rectifier Power Unit), using one type 5U4-G tube, furnishes 300 volts d.c. for the marker oscillator and its amplifiers, the multivibrator, the sweep generator and its amplifier, the video amplifier, and the PPI focusing coil. Bias voltage is obtained through a voltage divider tap from a regulated supply.

8. RECTIFIER POWER UNIT.

a. GENERAL. — The Rectifier Power Unit supplies regulated and unregulated d.c. for the Receiver and Indicator. In addition it serves as a junction box for interconnecting cabling between several of the system units.

The 300-volt supplies for the Receiver and Indicator are electronically regulated. A separate 235-volt supply, not regulated, is provided to furnish the 105-volt receiver supply through a dropping resistor, which stabilizes the gain by reducing the plate voltage on i.f. tubes drawing more than average current. As such tubes usually have higher than normal transconductance, the action of *reducing* the plate voltage brings the gain *down* to average, while *increasing* the plate voltage brings the gain *up* to average. Since both of the 300-volt voltage regulation circuits are basically the same, only one of them will be discussed.

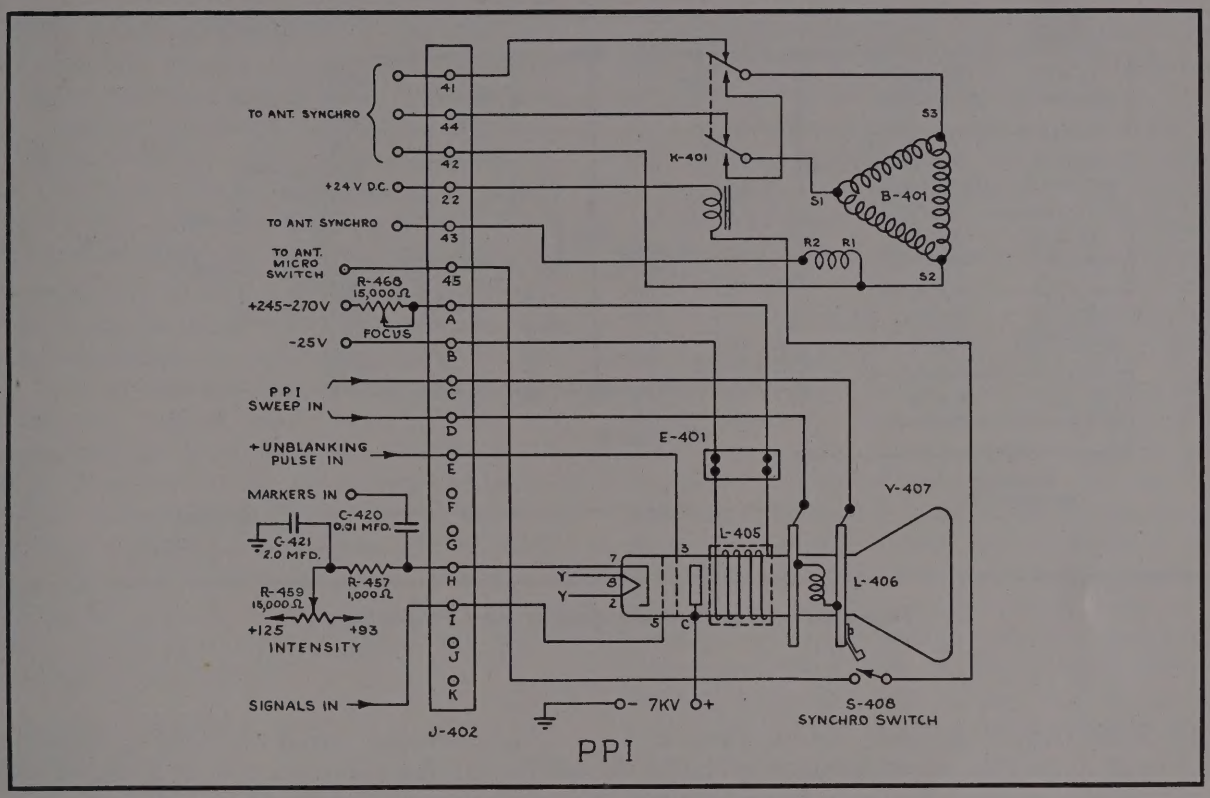


Figure 4-16—Plan Position Indicator: PPI Assembly

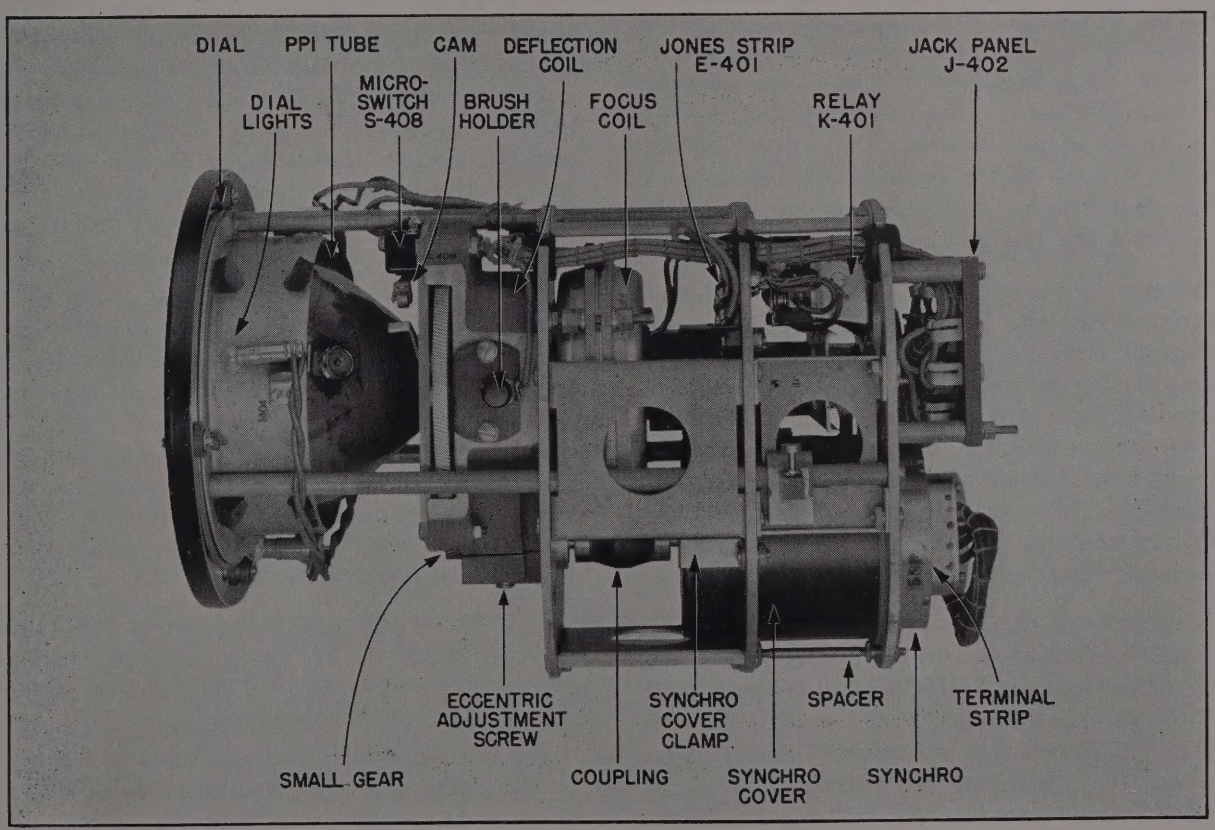


Figure 4-17—Plan Position Indicator: PPI Assembly

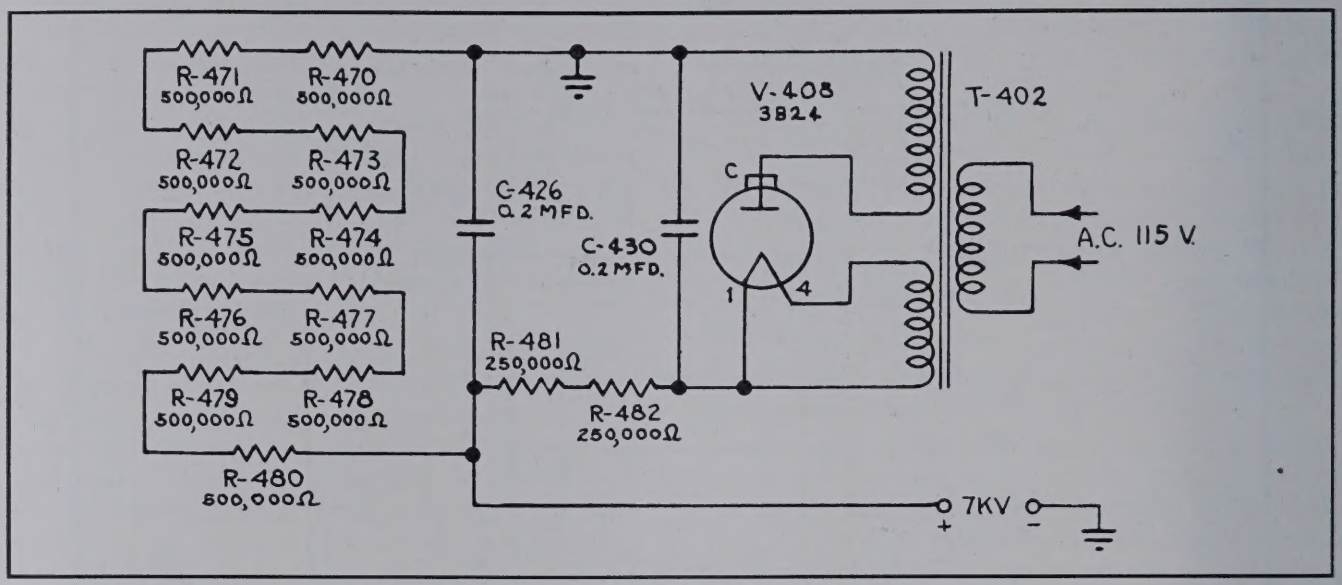


Figure 4-18—Plan Position Indicator: 7-kv. Power Supply

b. 300-VOLT REGULATOR. — Most of the current delivered to the load passes through the 6B4-G. The voltage drop across this tube is determined by its grid bias, which is controlled by the plate current of the 6SJ7-GT. This plate current is in turn controlled by the bias adjustment of R-211 and by the voltage drop between the 6B4-G cathode and −255 volts (which is regulated by VR tubes). R-211 can be adjusted so that the voltage on the 6SJ7-GT grid is either positive or negative to ground, determining the operating current of the 6SJ7-GT and the bias voltage on the 6B4-G.

Assume, for example, that the load suddenly draws more current. The voltage drop across the 6B4-G will increase, lowering the load voltage. This will make the grid of the 6SJ7-GT more negative, and the tube will draw less current. The voltage drop across the 6SJ7-GT plate load will decrease, making the grid of the 6B4-G more positive. The 6B4-G plate–cathode resistance will then decrease, reducing the drop across the tube and increasing the voltage across the load.

Now suppose that the load draws less current. There will be less drop across the 6B4-G, more voltage across the load, and more positive voltage from R-211 to ground, and the 6SJ7-GT will draw more current. The 6B4-G grid voltage will then become more negative, increasing the voltage drop across the 6B4-G and decreasing the voltage across the load.

Line-voltage variations will have a similar effect, varying the voltage drop across the 6B4-G so as to restore the normal load voltage.

Since extremely good regulation is required, a divider is connected between the regulated and unregulated side of the 6B4-G to supply additional control to the 6SJ7-GT. The combined voltage is supplied both by the voltage applied to the 6B4-G and the voltage delivered by the 6B4-G. By adjusting the balance between the control voltages from the two sources the 6SJ7-GT can make the 6B4-G over-regulate, under-regulate, or regulate almost perfectly.

Potentiometer R-211, which is in the resistor network across which the combined voltages are impressed, adjusts the 6SJ7-GT to the mean output voltage desired. By moving the arm of R-211 the average bias is varied and the reference plate resistance of the 6B4-G shifted accordingly. This in turn shifts the output voltage from the 6B4-G and establishes a new voltage about which the system will then regulate as before.

Thus, in the complete system, potentiometer R-211 establishes the regulated output voltage for the Receiver and potentiometer R-219 establishes the voltage for the Indicator.

All plate, screen, and bias voltages are supplied to the Receiver by the Rectifier Power Unit. The receiver filaments are powered by a small transformer on the receiver chassis.

c. AUXILIARY RECTIFIER. — The auxiliary rectifier supplies 24-volt d.c. for the following relays: magnetron plate voltage contactor, synchro, antenna rotation, a.f.c.-manual, and shutter solenoid. The 115-volt a.c. source is stepped down and rectified with a conventional bridge-connected rectifier. A 0.05-henry choke in the output circuit provides sufficient filtering for relay operation.

(1) RELAYS. — Relay K-202, operating from the main supply voltage, gives a delay of about three minutes before the auxiliary rectifier is energized. This allows the tubes to become heated before the relays can be operated and before power can be applied to the magnetron. Relay K-201 applies plate voltage to the magnetron and inserts a 1000-ohm resistor R-237 in the filament primary voltage supply for a 2J49 magnetron. Relay K-203 provides the holding contacts for re-cycling the time-delay relay; thus, timing relay K-202 drops out when the plate voltage is applied and K-203 holds the relay circuit closed.

9. ACCESSORY CONTROL UNIT.

a. GENERAL. — The chief function of the Accessory Control Unit is the generation, control, and calibration of the variable range mark which traces the range ring on the PPI screen.

In addition to the ranging system, the A.C.U. also contains several simple switches and controls which need no further explanation. The functions of these are given in Table 3-1. *List of Controls and Adjustments*, and their circuits are shown on the schematic.

b. LINEAR SAW-TOOTH GENERATOR AND PICKOFF DIODE. — Clamping tube V-701A normally conducts a small amount of current owing to the biasing network composed of R-701, R-736, R-737, and R-738. This establishes a potential at the plate of V-701A and across C-703 and C-702 which is considerably less than the regulated plate supply of 210 volts. This resting potential varies depending on the range in use, being approximately 50 volts on the low-range and 25 volts on the intermediate-range setting. The charging storage capacitor C-704 (driven by the cathode follower) has a charge of approximately the difference between the voltage at the plate of V-701A and the plate supply impressed on it.

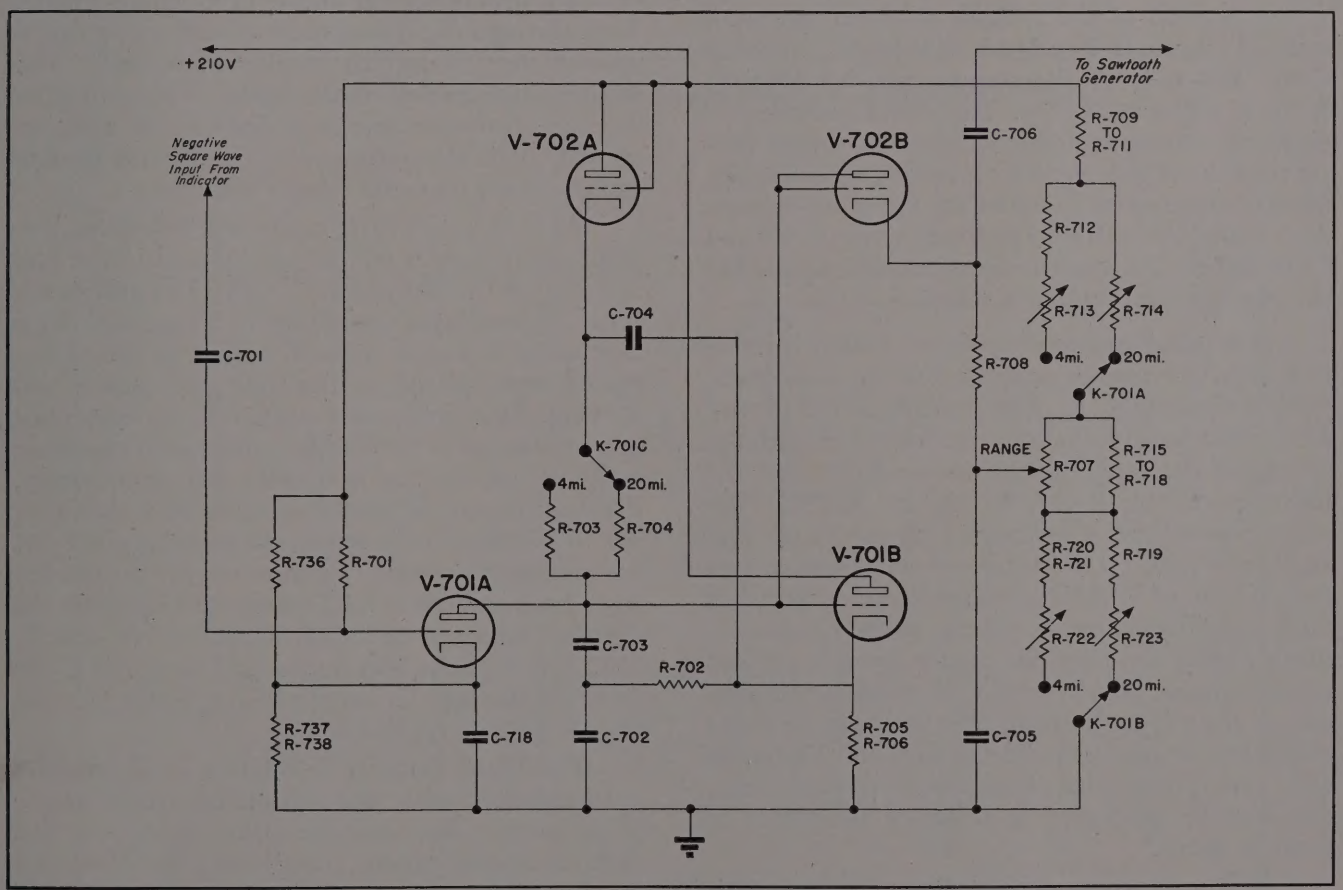


Figure 4-19—Accessory Control Unit: Linear Saw-Tooth Generator and Pickoff Diode

A negative square wave from the PPI multivibrator is applied to the grid of the clamper, biasing it to cutoff. This allows the linear saw-tooth generator capacitors C-703 and C-702 to begin charging toward plate supply potential through the series resistance of V-702A (the isolating diode) and either R-703 or R-704.

If the cathode follower were not contributing to the rate of charge of the saw-tooth generating capacitors, they would charge in such a manner that the voltage appearing across them would rise as an exponential function of time. However, the voltage appearing across the saw-tooth capacitors is also applied to the grid of the cathode follower V-701B and causes its cathode potential to increase at nearly the same rate as its grid voltage.

This rising voltage is applied to the cathode of isolating diode V-702A through C-704 and causes this tube to cease conducting. The only remaining source of charging current for the saw-tooth capacitors is then the initial charge on C-704 plus the added charge from the cathode follower as it is driven positive.

A portion of the cathode follower output is coupled through R-702 to saw-tooth capacitor C-702 and adds to the charge supplied through R-703 or R-704 and C-703. This added increment of charging current is adjusted, through proper proportioning of the circuit constants, to offset the normal exponential decay of the charging current. As a result, the voltage appearing across C-703 and C-702 during the time the square wave is applied to the clamper rises linearly with time.

This linear saw-tooth voltage, which is rising in a positive direction, is applied to the plate of the pickoff diode V-702B. The cathode of the pickoff diode has a positive bias on it which varies with the setting of the range potentiometer R-707 and the limit sets R-713, R-714, R-722, and R-723. The range potentiometer is coupled to the range dial and hand-crank. If the range of bias adjustment on the cathode of V-702B (through these controls) is made equal to the rise in voltage of the linear saw-tooth during the time the square wave is applied to the clamper, then by setting the range potentiometer to the proper position the diode can be made to conduct at any desired delay in time. The range dial, which is coupled to the range potentiometer, can then be calibrated in terms of thousands of yards of delay.

At the time the pickoff diode conducts, the voltage at its cathode suddenly starts to rise in a positive direction. This changing voltage is applied to a circuit which responds readily only to a changing voltage. This "differentiating" circuit applies a sharply rising voltage similar to a square wave to the grid of trigger amplifier V-703.

c. TRIGGER AMPLIFIERS AND BLOCKING (MARK) OSCILLATOR. — The plate current of trigger amplifier V-703 is coupled through a small pulse transformer to the grid of V-704A. The transformer characteristics are such that a voltage is developed across its windings only during the time that the current flow is changing rapidly. This condition exists at the beginning and end of the distorted square wave applied to the grid of V-703. The start of the wave applied to the grid of V-703 coincides in time with the conduction of the pick-off diode, and the end of the wave coincides in time with the removal of the square wave applied to the clamping tube V-701A.

The two sharp voltage pulses thus generated are applied to the grid of the second trigger amplifier V-704A which in turn is coupled through a similar transformer to the blocking mark oscillator V-704B. In addition the output of V-704B is coupled back through the transformer in such a way that it adds to the voltage pulse applied by V-704A. This highly regenerative circuit drives V-704B to plate current saturation within a fraction of a microsecond. This action coincides in time with the first pulse applied from the trigger amplifiers.

As soon as the plate current of V-704B reaches saturation, there is no voltage induced in the grid winding of the transformer T-705. The grid of the blocking oscillator then drops to a potential negative with respect to ground, owing to the charge stored on C-708 during the time grid current was flowing. This produces a sudden decrease in plate current flow in V-704B which, through transformer coupling, drives its grid still further negative. Plate current to the blocking oscillator is then shut off. Additional transients in the windings of T-705 are insufficient in value again to trigger the oscillator whose cathode is held above cutoff bias by the divider composed of R-729, R-730, R-731, and R-732. The negative bias on the grid capacitor C-708 leaks off through its shunt resistor before the next trigger pulse is applied.

The Mark Control R-734 is a dual 200-ohm potentiometer with one section connected in the plate current feed and the other section in the cathode current circuit. The sharp pulse developed by the sudden change in plate current to V-704B appears across the plate resistor as a negative volt-

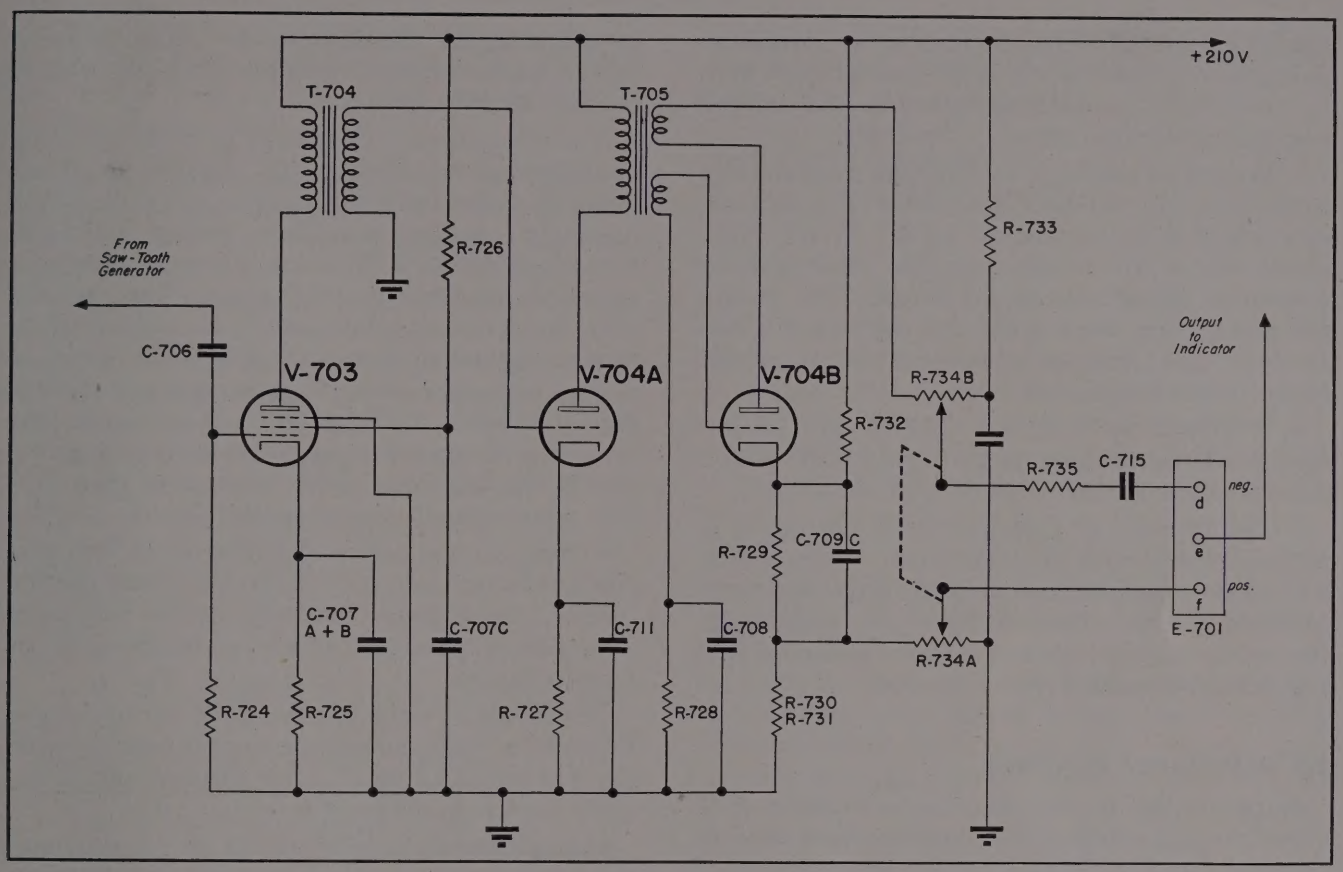


Figure 4-20—Accessory Control Unit: Trigger Amplifiers and Blocking Oscillator

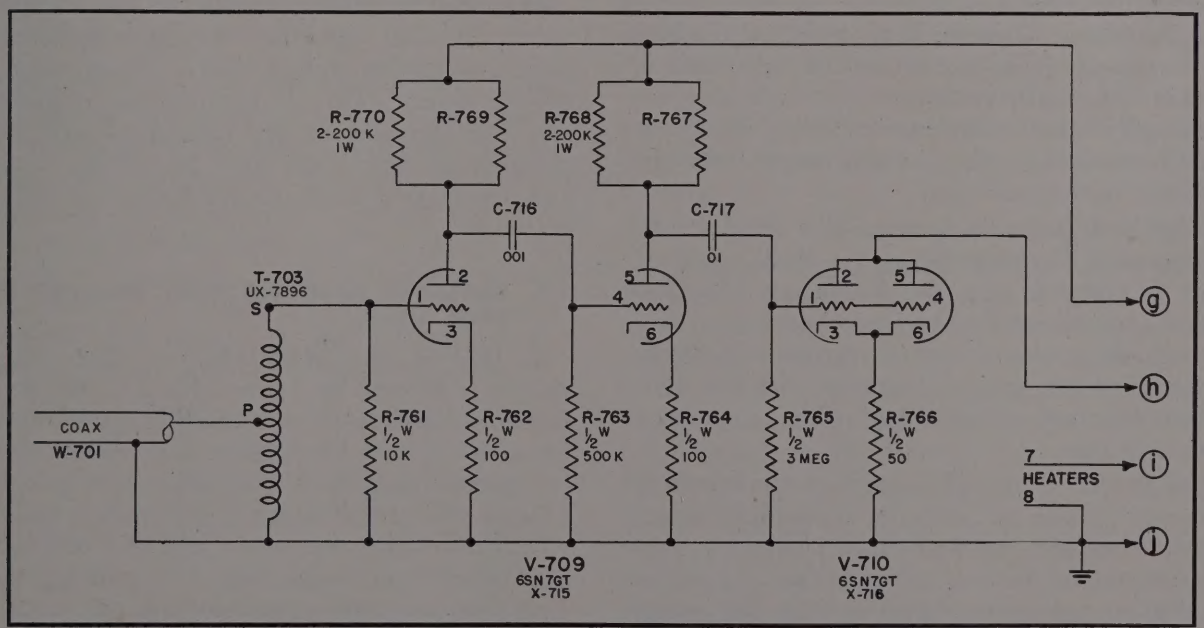


Figure 4-21—Accessory Control Unit: Resonance Chamber Tuning Amplifier

age and across the cathode resistor as a positive voltage. A portion of either of these outputs may be selected by properly positioning the output connecting link on terminal strip E-701.

Because of the high value of the current pulse to the blocking oscillator it is necessary to use both decoupling and attenuating circuits in the plate circuit output, and to use a very low value of shunt resistor in the cathode output circuit. This results in a clean, sharp mark at the time the pickoff diode conducts, and filters out all minor transients which might produce confusing results.

d. POWER SUPPLY. — The power supply furnishes both regulated and unregulated B voltage as well as a.c. for the filaments and pilot lights.

The rectifier is a conventional one using a pi-section filter with capacitor input. Unregulated d.c. is taken from the output of the filter; regulated 210-volt d.c. is obtained from the same filter through a voltage-regulator circuit employing two type VR105-30 tubes V-705 and V-706.

10. RESONANCE CHAMBER.

To permit tuning of the Receiver in the absence of actual targets, a Resonance Chamber (Echo Box) is provided (see Fig. 5-25).

This device is actually a high-Q resonant circuit in the form of a small cylinder. At one end of the cylinder is an adjustable disk plunger which varies the volume of the chamber. The plunger is adjusted by a cam, which is motor-driven and operated by a switch on the A.C.U.

The Resonance Chamber is mounted on the end of a short waveguide section whose other end is tapped into the main waveguide run. As this branch is electrically a half-wavelength section, the Resonance Chamber is, in effect, loosely coupled directly to the side of the main run.

Energy from the main waveguide is coupled into the Resonance Chamber through a small opening. Energy is coupled from the Resonance Chamber through a second opening into another short waveguide section in which a crystal rectifier is inserted. The circuit of this crystal, together with the two-stage amplifier and meter in the A.C.U., serves as a tuning indicator.

When the Resonance Chamber is properly tuned, the energy picked up from the waveguide causes oscillation within the Resonance Chamber. This excitation occurs for only one microsecond out of each 2150 microseconds, approximately; but owing to the high Q of the chamber, damped oscillations persist after the excitation stops. After decaying exponentially for 10 or 15 microseconds, these oscillations virtually die out.

A small portion of the energy from the decaying oscillations is rectified by the crystal in the Resonance Chamber and fed through a coax cable to the resonance chamber amplifier (tuning indicator) housed in the A.C.U. This amplifier comprises three cascaded resistance-coupled stages. The rectified pulse from the echo box crystal is applied to the input stage and appears at the grid of the last stage as a positive pulse whose duration and amplitude is maximum when the Echo Box is at resonance. The flow of grid current develops an average negative bias in the last stage which reduces the plate current proportionally to the applied signal.

A meter connected in the current lead to this stage indicates resonance by a minimum reading (dip). Thus a tuning indicator for the Resonance Chamber is provided which is independent of receiver tuning.

To provide an artificial echo signal for tuning the Receiver, a small amount of energy is returned from the Resonance Chamber back through the waveguide branch to the main waveguide run.

Here the energy is delivered via the r.f. system to the Receiver like a signal from an actual target. Assuming that this re-radiated energy affects the Receiver for ten microseconds, it will show up on the PPI tube (with the Antenna stopped) as a solid line extending from the start of the sweep to about the one-mile position.

In tuning the Receiver with the aid of the Resonance Chamber, optimum tuning is indicated by maximum length of the artificial echo signal as seen on the screen. This is because the receiver i.f. response increases as the tuning adjustment approaches its optimum, thus permitting reception and observation of the damped waves for a longer period.

11. ANTENNA ASSEMBLY AND BEARING CONTROL UNIT.

a. DRIVE MECHANISM. — The radiating system is rotated by a reversible d.c. motor. Mechanical coupling to the Antenna is accomplished by a simple speed-reduction gear train. On the low-speed end of the worm train, a spur gear drives a larger spur gear attached to the rotating assembly, which normally turns at a speed of 7 to 10 r.p.m. The latter is virtually locked in position by the gear train when the drive motor is off, preventing drifting of the Antenna in high winds.

b. R.F. SYSTEM. — The r.f. portion of the Antenna Assembly comprises a waveguide, a waveguide rotary joint, a feed nozzle, and a slatted parabolic-section reflector.

The microwave energy is transmitted through the rotary joint to the waveguide nozzle which radiates energy to the slatted reflector. The rectangular section at the waveguide nozzle (Fig. 1-3) confines the vertical radiation pattern of the nozzle to prevent overshooting the reflector. As some overshooting still occurs at the center of the reflector, future SO-4 Antennas may have absorbing material mounted on the reflector at this point or may employ a slightly different type of reflector. The nozzle is located near the focal point of the parabolic section, and the intensity and phase of excitation (illumination) of the various portions of the reflector is such that the pattern of the re-radiated (transmitted) beam is approximately 1.5° in the horizontal and 13° in the vertical planes.

As in any directional antenna system, this pattern is obtained by suitably combining the phases of the various radiation components arriving simultaneously at any point in the surrounding area. With a highly-directional system such as the SO-4, effective cancellation occurs over most of the surrounding area, and intense reinforcement occurs in a very small area, which is the path of the beam. The beam always lies in a fixed geometric relation to the reflector, and consequently sweeps over the surrounding area as the reflector rotates. The accompanying field patterns (Figs. 4-22 and 4-23) show the radiation in the vertical and horizontal planes in terms of power one way.

Impedance matching is accomplished by carefully adjusting the position of the "shepherd's crook" in relation to the center slat of the reflector. Matching must occur when the end of the waveguide feed is near the focal point, which must not vary in position more than $\pm\frac{1}{8}''$, according to production specifications. Each assembly is set to its correct match and tagged to show correct spacing. It must then remain at that setting, which must lie somewhere within the specified limits.

c. SYNCHRO SYSTEM. — Coupled to the rotating Antenna Assembly is a 5G synchro generator. Each revolution of this assembly produces ten revolutions of the synchro. The stator windings of the synchro are connected to the stator windings of the 5DG differential synchro B-1405 in the Bearing Control Unit. The rotor of the differential synchro is driven by a step motor operated by the ship's step-by-step gyro. The 5DG rotor windings are connected to the stator of a 1F synchro in the Bearing Control Unit and also to the stator of a 5F synchro in the Indicator. The 1F synchro, through a 10-to-1 speed-reduction train, rotates a cam and also a micro-switch for sector-synchronizing the Antenna, Bearing Control Unit, and Indicator. The 5F synchro drives the radial sweep coil of the PPI tube through a 10-to-1 speed-reduction train, thus causing the PPI sweep to follow the rotation of the Antenna.

The synchro system is designed to indicate true bearings only, and must be aligned after installation so that the PPI sweep points to the ship's true course when the Antenna points to the bow of the ship. The synchro system may be converted to indicate relative bearings by disconnecting and locking the step motor in the Bearing Control Unit (see *Locking the Differential for Relative Bearing*, page 5–24).

Since the torque of a synchro motor driven by a synchro generator falls to a low value when the alignment error between the two synchros approaches zero, an error of several degrees would result if the synchro motor in the Indicator were made to drive any considerable mechanical load. The loading effect of the rotating deflection coil is therefore minimized by driving the coil through a 10-to-1 gear reduction train.

Owing to the use of this 10-to-1 speed ratio, it is possible for the synchro system to get out of step in multiples of complete synchro revolutions, thereby introducing an error of 36° or of multiples of 36°. To correct such errors, a synchro-phasing system is included which automatically checks the PPI sweep and re-synchronizes it with the Bearing Control Unit once every revolution. A similar arrangement synchronizes the Antenna to the Bearing Control Unit during the same period. Synchro phasing is accomplished as follows (see Fig. 5-21):

The rotating cam assembly of the Antenna includes a cam having a width of about 18°. This cam opens micro-switch S-501 once every revolution of the Antenna as the latter passes the bow (0° relative position). The rotating gear assembly of the 5DG and step motor in the Bearing Control Unit includes another cam having a width of about 12°. This cam closes micro-switch S-1409. S-1409 is revolved by the 1F synchro B-1406 (on the same axis as its cam) and is closed once each revolution. Micro-switches S-501 and S-1409 are connected in series with the coil of sector-synchronizing relay K-1401 in the Bearing Control Unit. When this

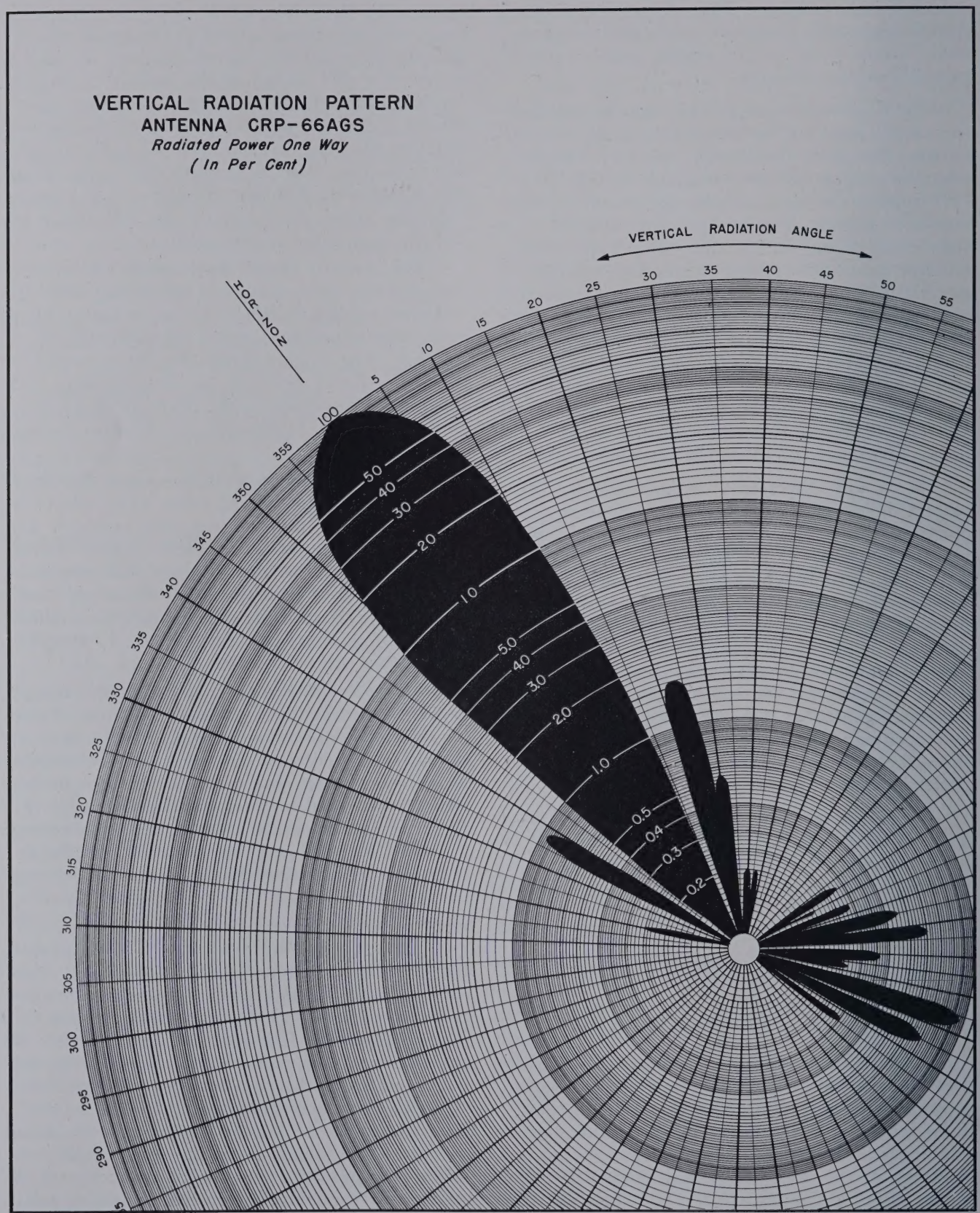


Figure 4-22—Vertical Antenna Pattern

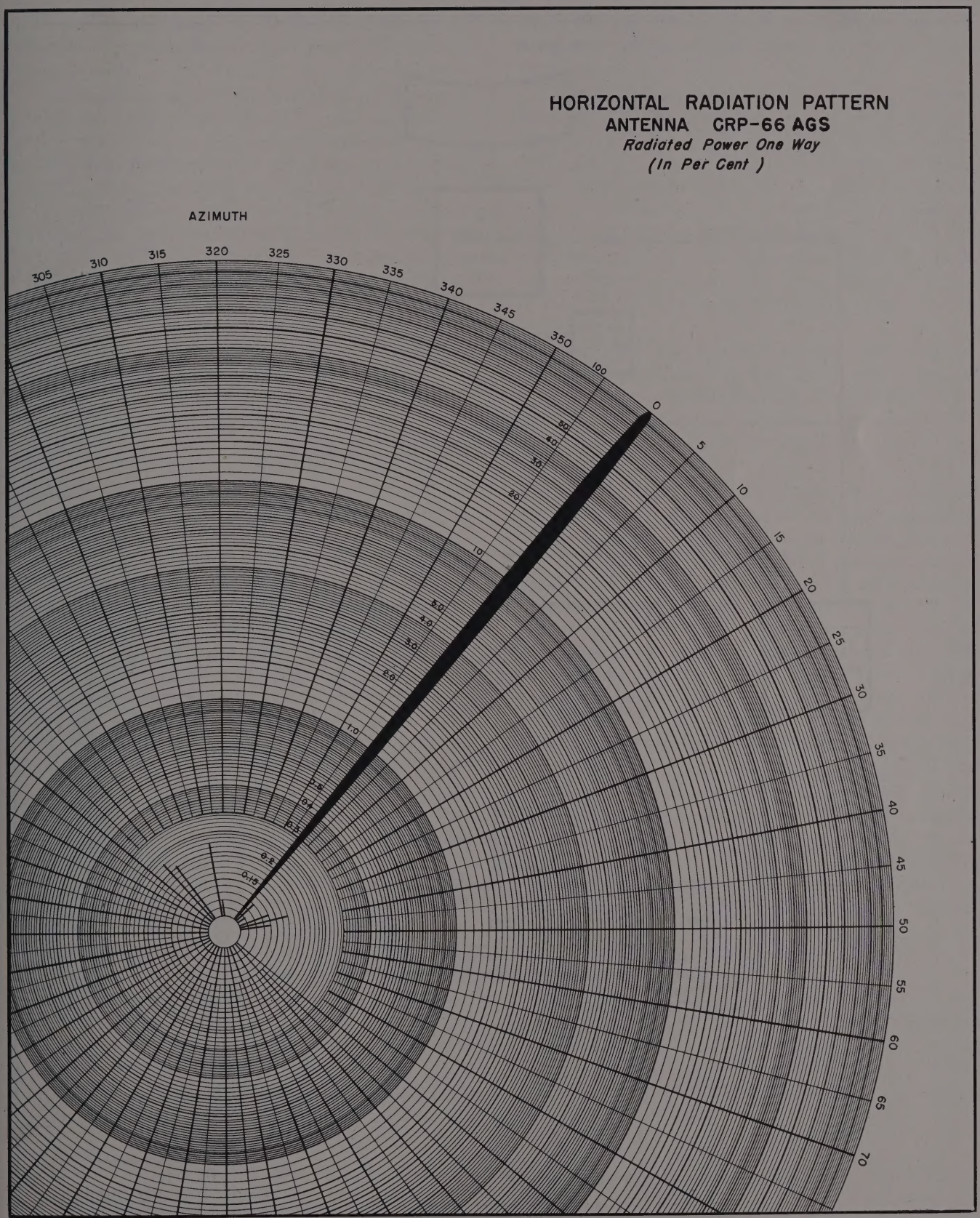


Figure 4-23—Horizontal Antenna Pattern

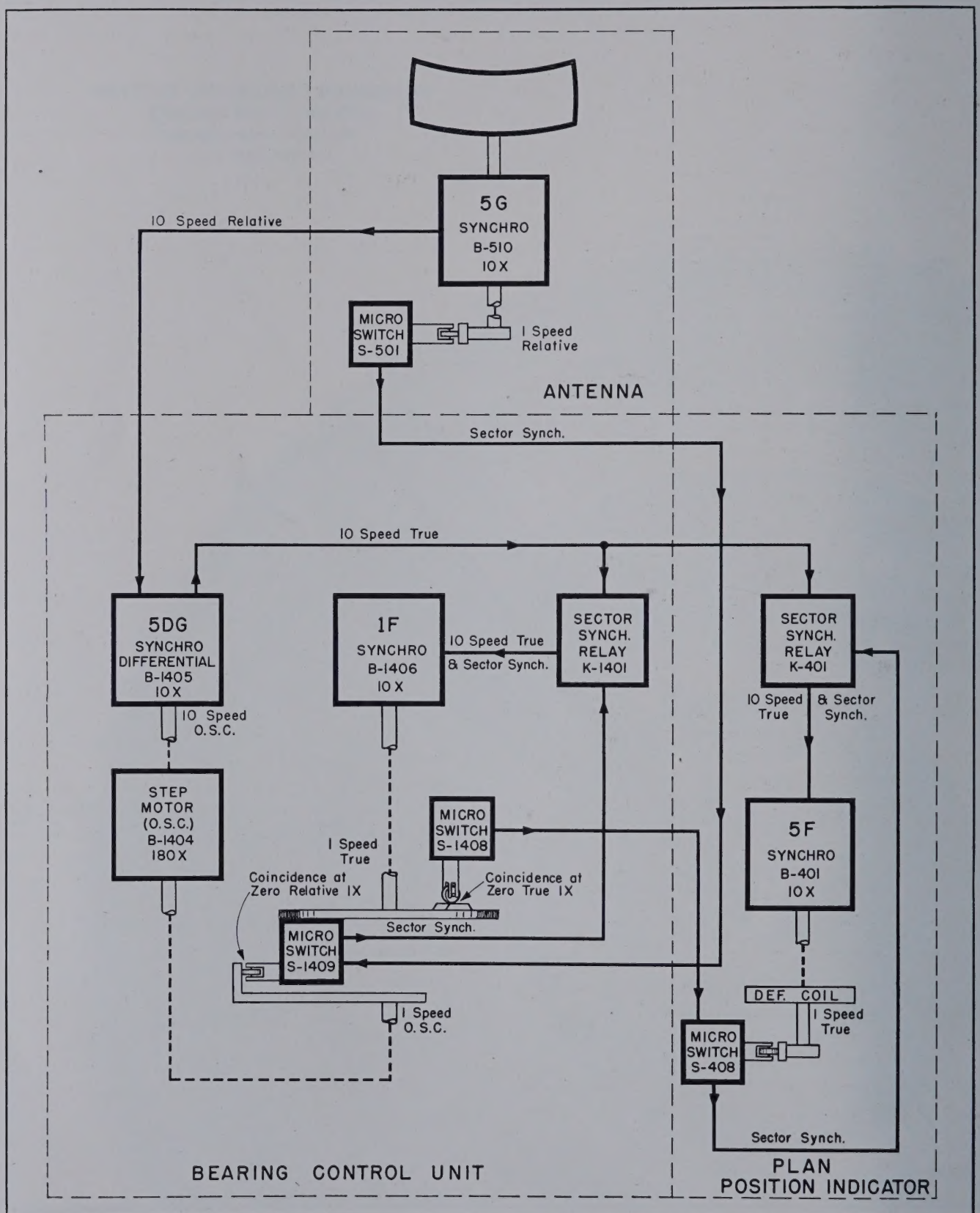


Figure 4-24—Synchro Block Diagram

relay closes, the stator leads S1 and S3 of the 1F synchro are disconnected from the 5DG synchro and connected so as to lock the 1F at electrical zero.

If the Antenna and the rotating micro-switch S-1409 are exactly synchronized, relay K-1401 remains open. This is because the antenna micro-switch opens just before S-1409 closes, and (owing to the greater width of its cam) remains open a short time after S-1409 opens. Should the two switches get out of synchronism, the 1F synchro will lock when S-1409 engages its cam, because S-501 and S-1409 are both closed, thus causing the relay K-1401 to close and lock the 1F synchro. In this event, the Antenna continues to rotate, and as it nears the bow of the ship, the antenna cam opens micro-switch S-501, opening the relay. This action starts off the 1F synchro in step with the Antenna.

Since the cam that operates the micro-switch S-1401 is rotated by the step motor, its position is representative of the ship's heading. It then follows that, whatever the ship's course, the Antenna and Bearing Control Unit will synchronize as the Antenna passes the ship's bow.

Still referring to Fig. 5-24, it can be seen that the 1F synchro is driven by the output of the 5DG synchro B-1405 and therefore is operated by true-bearing information. The 5F synchro in the Indicator is also operated from this same information; however, this synchro may lock into any one of 36 positions, only one of which is correct. Therefore, another micro-switch and relay arrangement is used to start off the indicator sweep on the right sector. The 1F synchro rotates a cam (on the same shaft as micro-switch S-1401) at one speed. This cam opens micro-switch S-1408 once each revolution. The rotating sweep coil assembly in the Indicator includes a cam which closes micro-switch S-408 once each revolution as the sweep passes the 0° position of the indicator sweep. As in the case of the Antenna and Bearing Control Units, the indicator sweep will lock and not rotate unless it is in step with the 1F synchro in the Bearing Control Unit. K-401 is the synchronizing relay which holds the PPI sweep coil at 0° until the 1F and 5F synchros are in step.

To summarize the synchro operation:

The antenna synchro transmits 10-speed relative-bearing information to the Bearing Control Unit. The antenna cam and micro-switch transmit one-speed synchronizing information to the Bearing Control Unit.

O.S.C. is introduced into the Bearing Control Unit to change relative-bearing to true-bearing information. The Bearing Control Unit converts (through a differential synchro) the 10-speed relative-bearing to 10-speed true-bearing information, and transmits this to the Indicator. Likewise, the Bearing Control Unit converts the one-speed relative-bearing synchronizing information (through the one-speed cams of the 1F synchro) to true-bearing information and transmits this to the Indicator.

The indicator synchro receives the 10-speed true-bearing information and drives the indicator sweep at one-speed true bearing. The Indicator also receives the one-speed synchronizing information and checks it against the one-speed operation of the sweep rotation.

The 10-speed synchro alignment is checked once each antenna revolution by the one-speed cams and micro-switches. Rotation of all synchros is continuous if the system is in alignment. Should the 10-speed system between the Antenna and the Bearing Control Unit get out of alignment, the 1F synchro will lock at 0° relative and then lock in step when the Antenna passes the bow. Should the 10-speed system between the Bearing Control Unit and the Indicator get out of alignment, the indicator synchro will lock at 0° true bearing and then lock in step when the 1F synchro passes this point.

It can be seen that the one-speed cams of the 1F synchro, in correcting an error between the Antenna and the Bearing Control Unit, *momentarily* change the 10-speed system of the Indicator to relative. At most, this occurs for only two revolutions of the indicator sweep, by which time synchronization will be established for the entire system.

12. JUNCTION BOX.

The circuits between the Antenna, Bearing Control Unit, Indicator, and Modulator make juncture in this unit. Relays K-1301 and K-1302 control the operation and direction of antenna rotation. They are operated by the Antenna Switch on the Indicator.

TABLE 5-0.—SYMPTOMS OF FUSE FAILURE

WARNING: Never replace a fuse with one of higher rating unless continued operation of the equipment is more important than probable damage. If a fuse burns out immediately after replacement, do not replace it a second time until the cause of trouble has been corrected.

Signals on PPI	*Antenna Rotation*	*Thyratron Glowing*	*Sweep on PPI*	*PPI Dial Light*	*A.C.U. Line Meter*	*Trans-mission**	*Blown Fuse*	*Value (Amps.)*	*Comments*
No	No	No	No	No	Not reading	No	F-2001	10	Motor alternator will not start
No	No	No	No	No	Not reading	No	F-2002	10	
No	No	No	No	No	Not reading	No	F-101	10	
Yes	No	Yes	Yes	Yes	Reading	Yes	F-102	2	Also check disabling switches
No	Yes	See comment	No	Yes	Reading	No	F-103	2 (Delay fuse)	Thyratron filament will not be lighted
No	No	No	No	No	Not reading	No	F-104	2	
Yes	Yes	Yes	Not rotating	Yes	Reading	Yes	F-105	6	Also check F-403
No	Yes	No	No	Yes	Reading	No	F-106	2	
Yes	No	Yes	Yes	Yes	Reading	Yes	F-107	3.2 (Delay fuse)	Also check F-102
Yes	Yes	Yes	Yes	Yes	Reading	Yes	F-109	3.2	Antenna heaters cold
No	Yes	Yes	No	Yes	Reading	Yes	F-201	1	Blower not heard running in Transmitter (thermostat shuts Transmitter off when overheated); receiver tubes cold
No	No	Yes	No	Yes	Reading	No	F-202	1	
No	Yes	Yes	No	Yes	Reading	Yes	F-203	2	Tubes in R.P.U. cold
No	Yes	Yes	No	Yes	Reading	No	F-206	3	Magnetron cold
No	Yes	Yes	No	Yes	Reading	Yes	F-207	2	
No	Yes	Yes	No	Yes	Reading	Yes	F-401	1	V-408 cold
No	Yes	Yes	Not rotating	Yes	Reading	Yes	F-403	6	Also check F-105
No	Yes	Yes	No	No	Reading	Yes	F-404	2	
No A.C.U. mark signal	Yes	Yes	Yes	Yes	Not reading	Yes	F-701	2	
Yes	Yes	Yes	Yes	Yes	Reading	Yes	F-702	3	Echo Box will not tune; A.F.C. not working

** To check the transmission, hold a neon bulb between the nozzle and the reflector. If transmission is good, the resultant glow will be easily visible; if transmission is weak, the glow will be weak.*

SECTION V. MAINTENANCE

1. PREVENTIVE MAINTENANCE.

The best kind of maintenance is Preventive Maintenance. This is proved by a digest of service reports received on SO-Series Radar Equipment. Preventive Maintenance includes periodic lubrication, inspection, and adjustment of the equipment. These, covered in the following pages, should be thoroughly studied.

The key and guide to this program is the *Routine Maintenance Schedule* following this page. All operations listed should be performed at least as often as the table indicates.

Through the careful following of this schedule, troubles can be detected at the start and remedied before they cause a real breakdown at a time when a breakdown might be disastrous. Major replacements can thus be avoided. The old saying, "A stitch in time . . . " is especially true of Radar maintenance.

Instructions for carrying out all routine maintenance operations, arranged by units, are given later in Sec. V. 3. Many special maintenance operations are also described.

2. LOCATING TROUBLE.

a. QUICK CHECK-UP AFTER EQUIPMENT FAILURE. — If the equipment should fail while on active duty, the operator should attempt to get it running again by carrying out the following quick check-up procedure:

(1) Check the fuses (see "*Fuse Locations*," page 5-30). *Blown fuses are the most likely cause of failure.* The fuses in the Modulator and Rectifier Power Units can be checked by opening the doors, throwing the Battle Switches to the "On" position, and observing the fuse indicators.

WARNING

Before replacing fuses, remember to turn off the main power supply to avoid injury from high voltage.

(2) Check the interlock, located in the Transmitter-Receiver. This switch may open under vibration. By striking a firm blow on the unit case near the interlock, the interlock can often be reseated and normal operation of the equipment restored.

(3) Make sure that all tubes are lighted. Glass tubes can be checked by inspection; metal tubes will feel warm to the hand if lighted.

b. LOCATING FAULTY UNITS.

(1) GENERAL. — If normal operation cannot be restored by the quick check-up already outlined, the trouble is probably due to failure of one or more components within a unit.

Assuming that all fuses have been checked, the search for the source of failure should start with close observation of the control panel and PPI screen on the Indicator. After the trouble is isolated to a single unit, it should be further isolated to components by making voltage and resistance checks.

When the equipment is operating normally, the PPI is easily read and interpreted. The trace sweeps evenly around the PPI screen. A moderate amount of "snow" is evenly distributed over the screen surface. The markers describe perfect circles, and the targets are sharp and clear. The bearing dial lights respond to the adjustment of PILOT Control **L**.

On the other hand, faulty operation of the equipment will almost invariably show up in abnormal appearance of the PPI screen or abnormal functioning of the operating controls, and these symptoms will point to the faulty unit.

(2) MODULATOR CHECK. — Failure of the dial lights and absence of the PPI trace indicate loss of power to the equipment, which points to a faulty supply generator. First check PILOT control **L** by turning it up to maximum. If the dial lights are still completely out, the generator may be dead. If the dial lights come up but no trace appears on the PPI, the generator is functioning. If the thyratron is firing smoothly as indicated by a bluish glow, the Modulator may be assumed to be operating properly.

An intermittent PPI trace may be caused by incorrect adjustment of the multivibrator bias control R-429.

If the dial lights are on but no trace at all is obtained, set N-E Switch **E** to the "E" (Emergency) position while holding the START Button in. (The protective relay may have opened because of a temperature rise in the Transmitter-Receiver.) If no trace is obtained on the PPI even at the emergency position, the Modulator may be defective.

TABLE 5-1.—ROUTINE MAINTENANCE SCHEDULE

All maintenance operations outlined below should be performed at least as often as indicated. Detailed instructions are given under appropriate headings in the pages following this table.

1. ONCE A WEEK:

(*a*). Blow out interior of Modulator Unit, Rectifier Power Unit, and Junction Box with dry compressed air.

(*b*). Wipe out units with dry cloth.

(*c*). Wipe off high-voltage insulators with a clean dry cloth.

(*d*). Inspect relays of Rectifier Power Unit and Junction Box for dirt.

(*e*). Check all cables for sharp bends and possible cable injury.

2. ONCE A MONTH:

(*a*). Perform all weekly operations.

(*b*). Inspect and tighten all connections at terminal strips. Check cable connectors.

(*c*). Inspect all dehydrator plugs and replace if necessary.

(*d*). Inspect all relay contacts and interlock switches. Clean or burnish as necessary.

(*e*). Inspect and clean ferrule resistors, fuses, and clips.

(*f*). Inspect tube socket connections and tube locks.

(*g*) Inspect blower motor and replace brushes if they are shorter than $\frac{5}{16}''$.

(*h*). Inspect all stuffing tubes and tighten as required.

(*i*). Check d.c. voltage output of Rectifier Power Unit and Junction Box (after a warming-up period of one-half hour), and adjust or replace if required.

(*j*). Inspect PPI gears for binding or foreign matter lodged in them.

(*k*). Check waveguide for tightness of bolts.

(*l*). Inspect Motor-Alternator bearings, commutators, slip rings, and brushes.

(*m*). Inspect and lubricate Antenna Assembly.

(*n*). Check waveguide shutter for free action.

(*o*). Check TR assemblies for tightness and spacings and tune.

(*p*). Check crystal mixer current and adjust oscillator coupling if necessary.

(*q*). Check all tubes for tightness, including the PPI tube.

(*r*). Check mechanical operation of Echo Box.

(*s*). Check Antenna for alignment, and inspect for loose bolts.

(*t*). Every 500 hours of operation, replace TR and ATR tube assemblies.

(*u*). Check all coax cable fittings.

(*v*). Inspect J-401 and P-401 on Indicator for corrosion.

(*w*). Check gland packing around all controls on Indicator and A.C.U. for tightness.

(*x*). Lubricate the small PPI drive gear shaft bearings and both bearings of deflection coil with a few drops of Univis P-48 oil.

3. ONCE A YEAR:

(*a*). Perform all weekly and monthly operations.

(*b*). Dismantle and clean Antenna Assembly. Inspect main spindle bearings, main drive gears, and antenna drive motor, and replace worn parts if necessary. Lubricate all parts.

(*c*). Dismantle and inspect antenna and indicator synchros. Remount and align.

USE OF RADAR LOGS

Three kinds of Radar log forms are available at bases. One copy of each form should be placed in the log holder, which is mounted on or near the equipment.

(a) *The modification log* should contain a short history of equipment modifications. Every change made in the equipment should be entered in this log at the completion of the work.

(*b*) *The unit replacement log* should be posted in pencil with the serial number and Navy type number of every unit in the equipment. Whenever a unit is replaced, the serial and Navy type numbers of the old unit should be erased and the new numbers substituted.

(c) *The servicing memoranda sheet* should be used for making a record of unfinished work, component replacements, etc. This record will be invaluable for future servicing work.

(3) TRANSMITTER CHECK. — If the trace and marks appear on the PPI, but no signals, the trouble may be either in the Transmitter-Receiver or in the Indicator. First, however, the coax cable connectors should be checked. If the trouble still persists, the Transmitter should next be checked for normal operation. There are two ways of doing this:

(*a*) Tune the Echo Box as outlined in Sec. III. 8. *Use of Resonance Chamber*. If the usual dip is observed on Meter **13**, the Transmitter is radiating.

(*b*) Hold a neon lamp in front of the antenna nozzle. If it glows, the Transmitter is radiating. (Neon lamps provided as blown-fuse indicators are available in equipment spares.)

(4) RECEIVER AND RECTIFIER POWER UNIT CHECK. — If the Transmitter is found to be operating normally, the Receiver may be at fault. Before assuming this, however, examine the Rectifier Power Unit, which supplies power to the Receiver. Make sure that all tubes are lighted by looking through the louvers. (The Rectifier Power Unit is not likely to fail.) Except for replacement of tubes and fuses and burnishing of relay contacts, this unit ordinarily requires no maintenance.

The Receiver is difficult to check without instruments. If "snow" is obtained on the PPI tube when GAIN Control **C** is far advanced, the Receiver is probably functioning normally, although the mixer crystal may be defective. If no snow is seen, the trouble may be either in the Receiver or in the Indicator.

If the movable range mark from the A.C.U. appears normally on the PPI tube when the MARK Control is advanced the trouble is probably in the Receiver.

(5) INDICATOR CHECK. — If no signals appear on the PPI after checking the Modulator Unit, Transmitter-Receiver, and the Rectifier Power Unit, the fault probably lies in the Indicator. Remove the Indicator from its case and check with the hand for a cold tube.

(6) A.C.U. CHECK. — If the movable range mark generated by the A.C.U. does not appear on the PPI screen, but signals and PPI range marks are normal, the A.C.U. ranging system is inoperative. The most likely cause of trouble is blown fuse F-701.

c. LOCATING FAULTY COMPONENTS.

(1) GENERAL. — The following information is for the guidance of experienced personnel.

It is assumed that the trouble has already been traced to a particular unit. Since tubes are the most likely cause of failure, suspected tubes should first be replaced temporarily from spares. The faulty component can now be found in several ways, the most convenient being through voltage and resistance measurements. (See Tables 5-3 – 5-6.)

Voltage measurements should be made on the faulty unit to determine whether plate supply voltages are available at all tube sockets. *Owing to the dangerously high voltages employed in the Modulator Unit, high-voltage measurements should not be made*. If the thyratron is glowing, it may be assumed that these circuits are operating normally. In addition, the resistance of suspected parts may be taken and compared with values shown on schematics. (See the schematics for values of controls or refer to Table 3-1.)

Check condensers for short circuits. (Most condensers have shunt resistance, but shorted condensers can still be detected with an ohmmeter.)

The Indicator and Accessory Control Unit are so constructed that inter-unit cables are automatically disconnected when the chassis is withdrawn from the case. To permit checking these units under operating conditions, special test cables are included in equipment spares. These are used to connect the chassis of the Indicator or A.C.U., after removal, to the cable terminals in the case.

A Servicing Block Diagram and a Table of Test Point Locations are also provided in this section.

(2) WEAK OR INTERMITTENT RECEPTION OF ECHOES.

(*a*) A defective tube or intermittent short in tube.

(*b*) Local oscillator, TR box or ATR box improperly tuned (see page 5-10). A.F.C. out of tune (local oscillator on wrong side of signal frequency).

(*c*) Defective TR or ATR tube or local oscillator tube; dirty tube fins; loose tube cavities.

(*d*) Defective crystal cartridge in signal mixer or a.f.c. mixer.

(3) IRREGULAR MARKS AND FUZZY SIGNALS. — These may be caused by faulty adjustment of R-429, the multivibrator bias adjustment. To correct this trouble, proceed as follows:

(*a*) With the equipment off, remove the indicator chassis and connect between P-401 and J-401 the indicator test cable found in equipment spares.

(*b*) Turn on the equipment, *but do not start the Modulator. Advance the MARKS Control.*

(*c*) Adjust multivibrator bias control R-429 (located behind the indicator panel) until the range marks appear on the screen. Start the Antenna rotating and note these marks.

(*d*) Set the Range Switch to 80 and adjust R-429 until the marks disappear, continuing to rotate R-429 slightly beyond this point in the same direction. Turn the Range Switch back and forth several times, and if marks reappear, readjust R-429 until they disappear.

(*e*) Shut off the equipment, remove the test cable, and replace the Indicator in its case.

If the wavy marks are due to rapid fluctuations in the Motor-Alternator, inspect the speed and voltage regulators in the Motor-Alternator Control Unit, motor and alternating brushes. Wavy marks may be caused by tight antenna bearings. Fuzzy signals are sometimes due to a loose synchro coupling either in the Antenna or in the Indicator.

3. MAINTENANCE INSTRUCTIONS (By Units).

In the SO-Series Radar Equipment every effort has been made to provide maximum accessibility consistent with good electrical design. To facilitate maintenance and replacement, units are regularly provided with removable covers. The Indicator and A.C.U. use instead a special drawer-like arrangement which permits the chassis to slide in and out of its case. Connections to these two units are made by means of a jack board and plug board.

Procedures for replacing units are given under the various unit headings.

a. MOTOR-ALTERNATOR.

(1) GENERAL. — The Motor-Alternator was carefully tested and properly adjusted before leaving the factory. Brushes and contacts should be cleaned regularly, *but no other adjustments should be made without first determining that they are necessary.*

(2) BEARINGS AND ELECTRICAL CONTACTS. — Ball Bearings are used in the Motor-Alternator. These are packed at the factory but require repacking once a year with Andok C. To do this, remove the bearing retainer plate and fill the lubricant space three-quarters full.

Two brushes each are employed on the motor and alternator commutators. They should be replaced after 3000 hours of use or after $\frac{3}{16}$" of wear, whichever occurs first. (New brushes are $1\frac{1}{4}$" long.)

Commutators and slip rings should be inspected regularly, and polished with a clean dry cloth or piece of canvas. If this treatment proves inadequate for polishing, a piece of fine sandpaper or crocus cloth may be used. *Never use emery cloth or emery paper on commutators or slip rings.* If, however, the polishing cannot be properly done in place, the unit may be disassembled, and the commutator or slip rings may be turned down and polished on a lathe by a competent machinist.

b. MOTOR-ALTERNATOR CONTROL UNIT. — The Motor-Alternator Control Unit requires little attention since it has been carefully tested and properly adjusted before leaving the factory. All relay contacts should be inspected monthly and cleaned or burnished as necessary. The two torque motors, which provide voltage and speed regulation, require no attention.

c. MODULATOR UNIT. — This unit has been carefully tested and properly adjusted before leaving the factory. The K-101 relay contacts should be cleaned and inspected regularly. The expected life of the hydrogen thyratron tube is 1000 hours.

The charging on Z-101 in the Modulator is affected by the length of the pulse cable between the Modulator and Transmitter-Receiver. Long cables reduce the "overshoot" voltage on the thyratron, thereby reducing the voltage gain in the resonant charging circuit.

When the pulse cable is unusually long, it may be necessary to adjust the taps on T-101 in order to obtain the proper magnetron current reading of approximately 5.3 ma. at a 465-c.p.s. repetition frequency.

d. TRANSMITTER-RECEIVER.

(1) GAINING ACCESS FOR SERVICING.— Loosen all the wing captive screws under the unit and lift off the cover.

(2) SERVICING THE UNIT WHILE OPERATIVE. — Operate the unit with the cover off or with the access door open, as outlined later in this subsection under *Tuning the R. F. System.* The interlock must be bridged if the case is removed.

(3) REMOVAL FOR REPLACEMENT. — The cabling should be disconnected by separating the jack board from the plug board, leaving the cable terminals intact. The procedure follows:

(*a*) Disconnect pulse cable plug P-303 from J-303.

(*b*) Loosen the captive screws holding the large terminal box to the transmitter frame and remove the box complete with cables and jack.

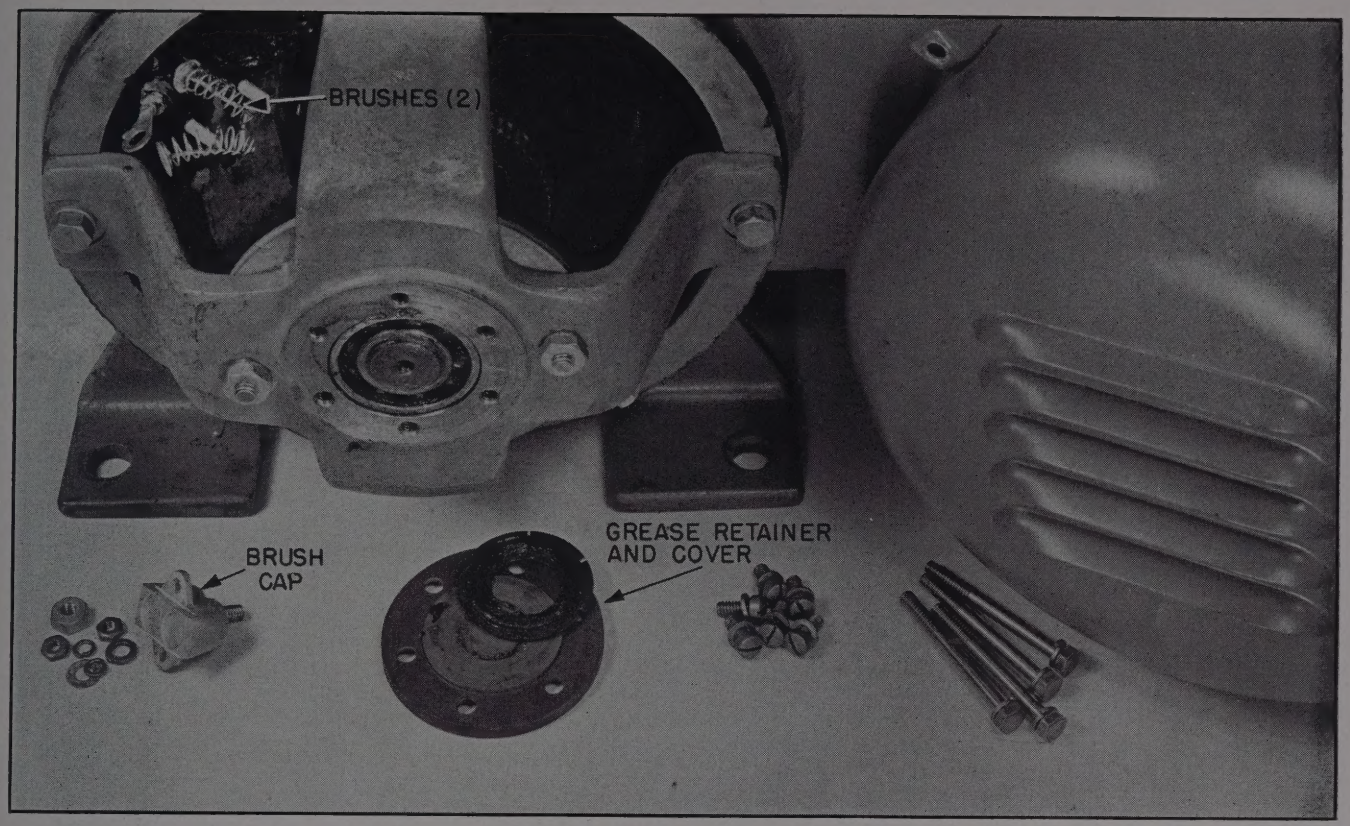


Figure 5-1—Motor-Alternator Unit

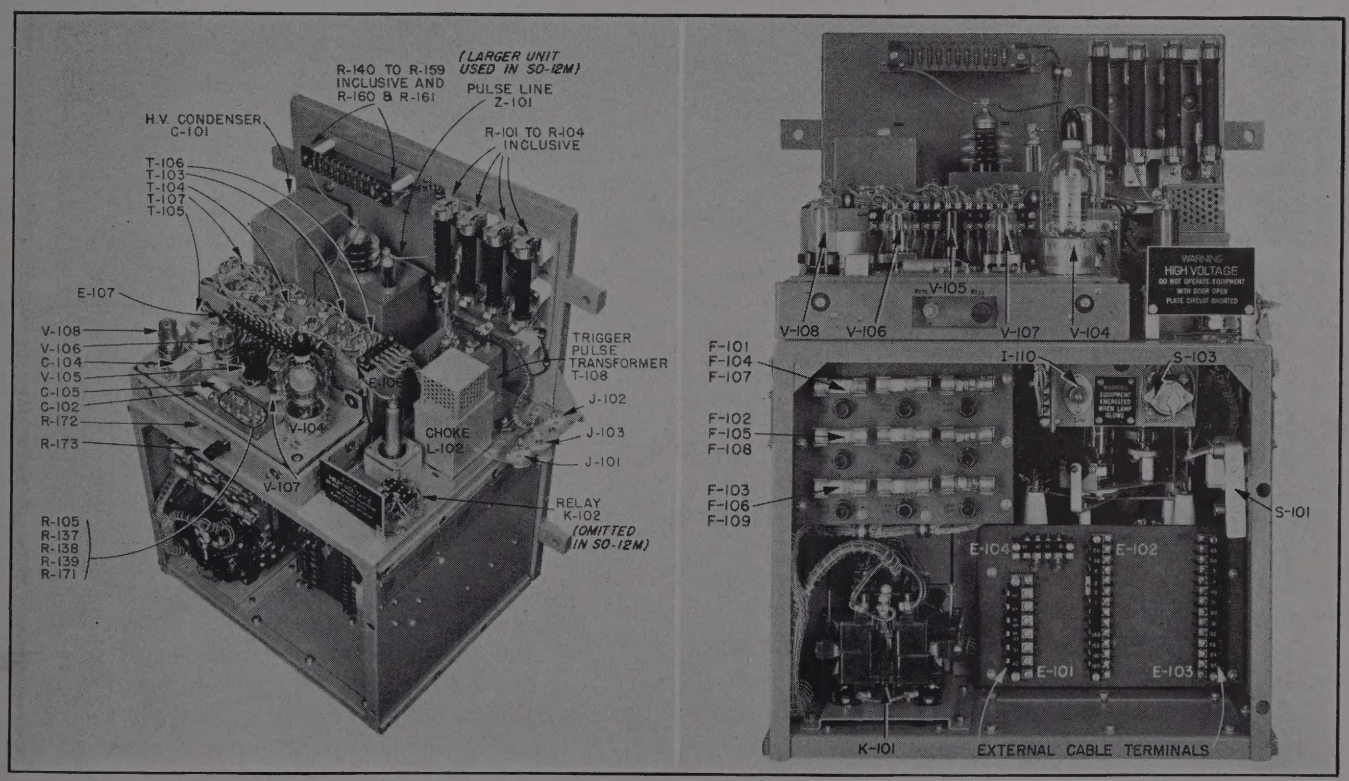


Figure 5-2—Modulator Unit

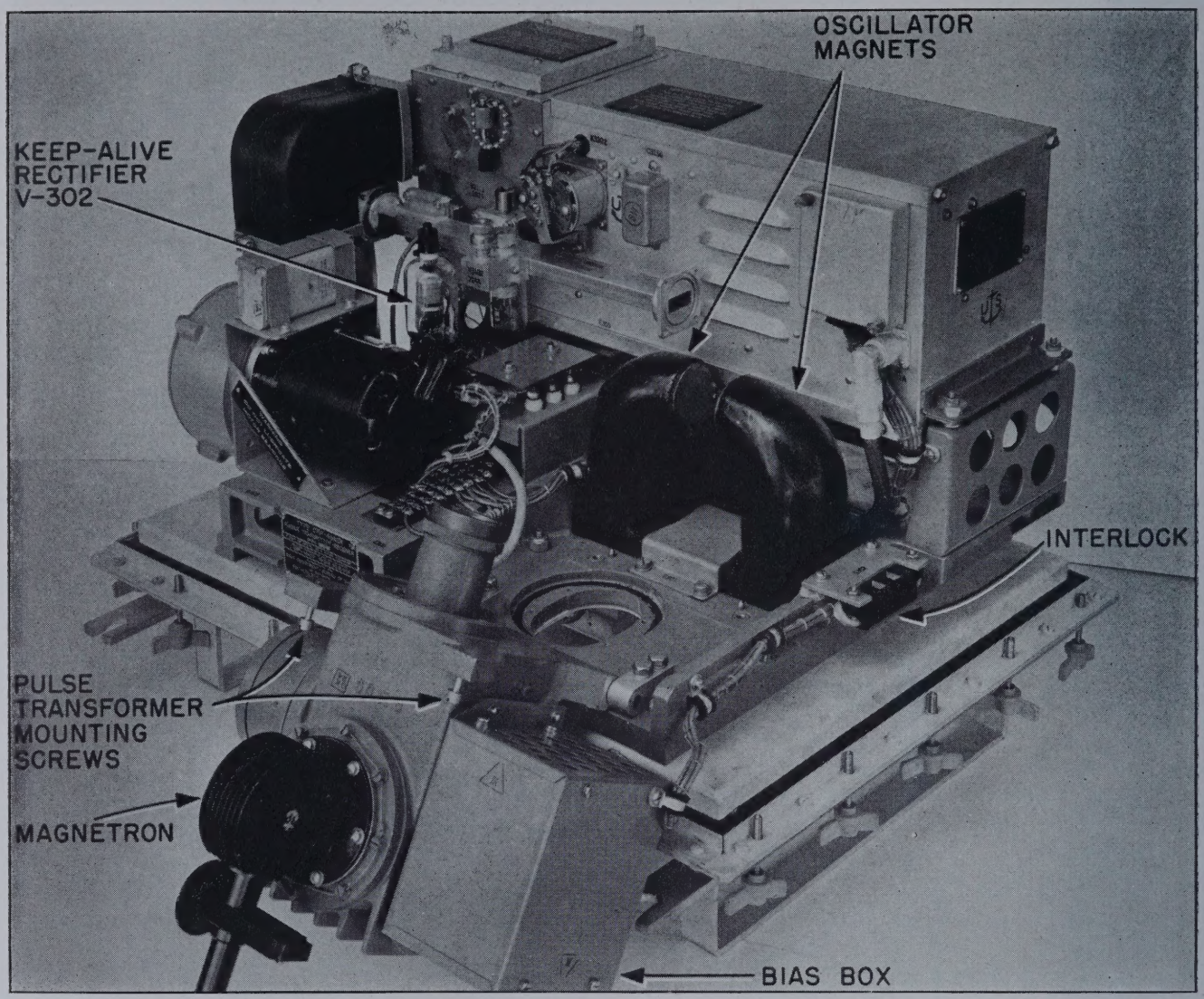


Figure 5-3—Transmitter-Receiver Unit: Interior with Pulse Transformer Assembly Hinged Back

(*c*) Remove the Transmitter Unit by loosening the mounting locks and waveguide flange bolts, and lifting out the unit.

(4) MAGNETRON OSCILLATOR.

(*a*) REMOVAL.

1. Remove the transmitter-receiver case.

2. Loosen the captive mounting screws on the lower inside corners of the pulse transformer.

3. Disconnect pulse cable plug P-303 from the underside of the unit.

4. Swing the pulse transformer outward on the hinge pin (see Fig. 5-3).

5. Loosen and remove the six fillister-head machine screws around the magnetron flange.

6. Remove the magnetron from the plug-in tube well.

(*b*) INSTALLATION. — Install the new magnetron by reversing the removal procedure given above.

Note

The type 2J49 magnetron has all coupling adjustments made at the factory; and a short length of waveguide (with flange) is included as a part of the tube. No tip or coupling adjustments of any kind can be made in the field. The air gap between the waveguide flange on the magnetron and the flange of RF-3101 should be approximately $\frac{1}{32}''$.

(*c*) REPLACEMENT OF MAGNET.

1. Remove the magnetron as outlined in steps (1)–(4) under *Magnetron Oscillator: Removal.*

2. Remove the four screws holding the magnet mounting bracket to the transmitter chassis. Lift out the magnet.

3. Install the new magnet (from spares) with its north pole facing the cathode end of the magnetron.

CAUTION

Handle the magnet with care, avoiding sharp impact and keeping the poles away from ferrous metals. The flux density should be 5250 gauss.

4. Place the mounting bracket over the magnet base and tighten the four screws.

(5) TR (DUPLEXING) TUBE AND CAVITY 1B24. — The type 1B24 TR tube and cavity are manufactured as a single assembly as shown in Fig. 5-11. After 500 hours of operation, this assembly should be replaced, regardless of its condition. Removal and installation procedures follow:

(*a*) REMOVAL.

1. Remove the transmitter-receiver case.

2. Remove from the waveguide flange the four fillister-head machine bolts holding the 1B24 in place.

3. Loosen the four fillister-head machine bolts in the flange which couples the waveguide to the a.f.c. mixer section.

4. Remove the keep-alive terminal cap from the bottom of the 1B24.

5. Carefully work the 1B24 out of the waveguide flange by sliding it down and turning the lower part of the tube to one side as required.

(*b*) INSTALLATION.

1. Install the new assembly by reversing the removal procedure given above, replacing the keep-alive terminal cap.

2. Tune the new assembly as outlined in step (4) on page 5-11.

3. Enter the date of replacement in the Radar log.

Note

The TR box tuning should be checked at frequent intervals. This may be done during routine weekly or monthly maintenance checks.

(6) ATR (ANTI-DUPLEXING) TUBE AND CAVITY 724A. — Unlike the 1B24 TR assembly, the 724A ATR tube is removable from its cavity. After 500 hours of operation, the tube should be replaced, regardless of its condition, and the old one discarded. (This 500-hour period may be revised when further information is available.) Removal and installation procedures follow:

(*a*) REMOVAL.

1. Remove the transmitter-receiver case.

2. Remove the knurled clamping rings and the small cylinders from the top and bottom of the ATR box.

3. Remove the two oval-headed machine screws from the outer surface of the box, and pull apart the two halves of the box.

4. Remove the tube from the cavity.

5. Enter the date of replacement in the Radar log.

(*b*) INSTALLATION.

1. If the fins of the new tube show signs of corrosion, cautiously clean them with a soft rubber eraser, then wipe them with a soft cloth moistened with carbon tetrachloride to remove any film of oil. Finally, wipe them with a clean dry cloth. Take care to avoid injuring the thin plating on the fins.

2. Install the new tube in the cavity, being careful not to bend the delicate fins on the tube, then reassemble the cavity by reversing the removal procedure given above.

Note

The small cylinders which fit above and below the ATR tube have one end machined to a larger inside diameter. This end goes next to the tube fins.
The terminal cap on the ATR tube is not connected to a keep-alive lead.

(7) MIXER ASSEMBLY.

(*a*) LOCATING A FAULTY CRYSTAL.— A crystal that rectifies poorly will cause weak signals. No means of checking crystal performance with simple test equipment is known. The only reliable field check is to substitute a new crystal and compare results.

Weak signals may be caused by a worn-out TR (duplexing) tube. This tube should be replaced every 500 hours, as previously outlined.

(*b*) REPLACING THE CRYSTAL CARTRIDGES. — The receiver input assembly is a rec-

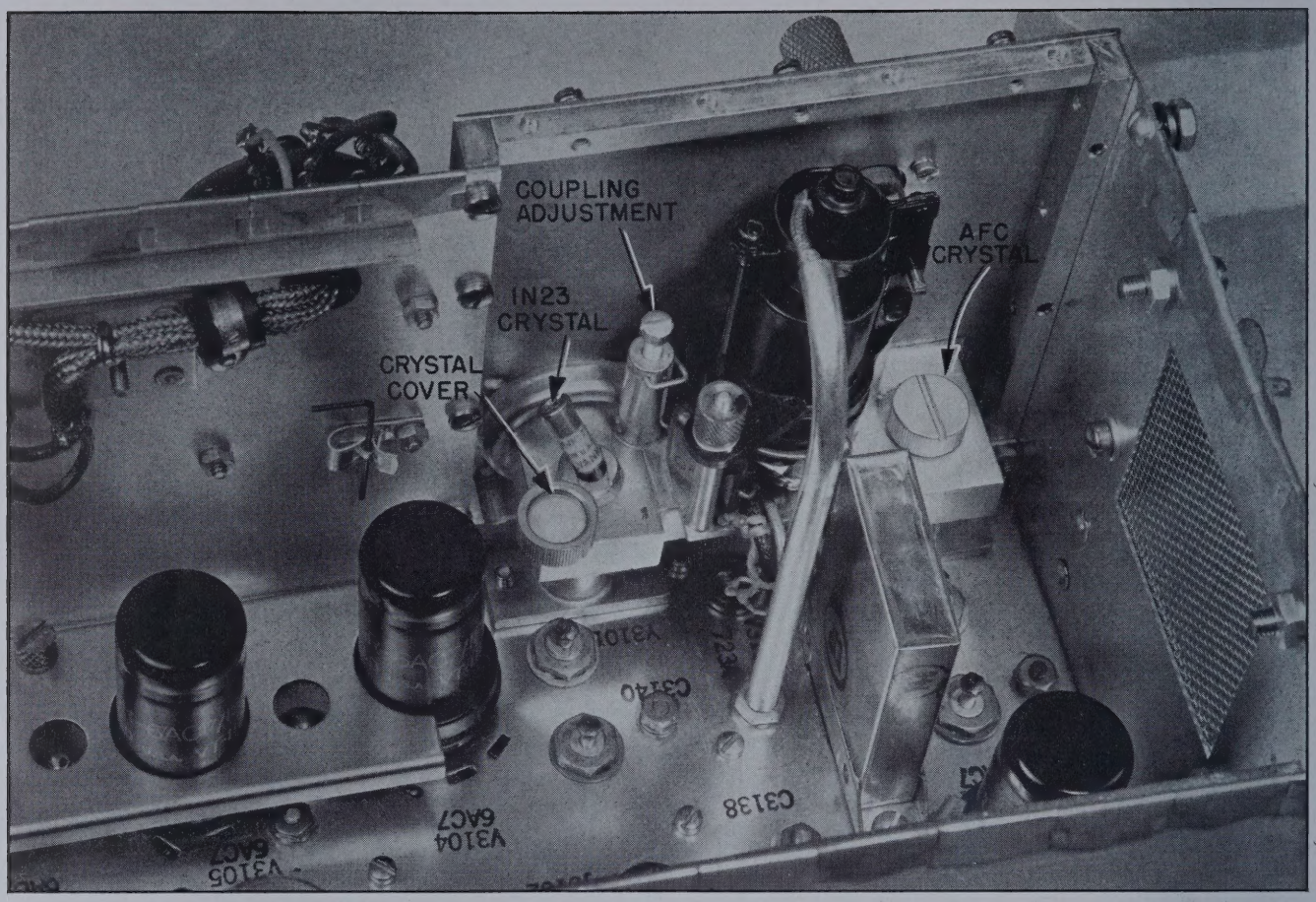


Figure 5-4—Receiver Chassis: Cover Removed, Showing R. F. Input Assembly

tangular U-shaped section of waveguide, most of which is located within the receiver case. The open ends of the U project from the side of the receiver case towards the blower motor. These ends are provided with flanges for attaching the pre-tuned r.f. system RF-3101 and the TR box. The flange nearest the end of the Receiver is the input to the a.f.c. mixer; the other flange is the input to the signal mixer.

The mixer crystals Y-3101 and Y-3102 are located beneath two small knurled caps at the ends of the base of the U-section input assembly (see Fig. 5-4). Replacement crystals should be type 1N23. These have the same resistance characteristics as type 1N21 but with a better conversion ratio on the X-band.

To replace a crystal, unscrew the knurled cap, and pull the crystal cartridge straight out by grasping it with the finger nails or by prying it out with a small screwdriver.

WARNING

Make sure that the receiver power is off, as the metal shell of the local oscillator cavity (between the crystal holders) is 300 volts above ground (chassis).

CAUTION

The crystal cartridge is fragile and may be damaged if dropped on a hard surface. When inserting a new cartridge, be sure that its tip enters the contact clip on the mixer and that the cartridge seats properly. A slight resistance should be felt as the tip slides into the clip. After installing a new cartridge, the mixer coupling and crystal current must be checked as outlined on page 5-10.

(8) LOCAL OSCILLATOR TUBE 723A. — The type 723A local oscillator tube is a reflex klystron. Since the cavity is an integral part of the tube, the assembly must be replaced as a unit.

WARNING

Note the warning regarding high voltage given above under *Replacing the Crystal Cartridge*.

(*a*) REMOVAL.

1. Remove the top cover from the Receiver.

2. Loosen the knurled thumb nut and swing aside the small phenolite clamp holding the tube in its socket.

3. Remove the plate cap lead.

4. Loosen the setscrews on the phenolite sleeve which couples the tuning shaft to the tuning screw on the side of the tube.

5. Carefully remove the tube from its socket by lifting up and away from the phenolite sleeve as required to clear the assembly.

CAUTION

The coax line which couples the tube to the waveguide mixer assembly projects through the tube socket. Be careful not to bend or damage this line when withdrawing the tube.

(*b*) INSTALLATION. — Install the new tube by reversing the procedure used for removal.

Note

After replacing the 723A local oscillator, it is necessary to retune the cavity; and it is usually necessary to readjust the repeller voltage (by means of TUNE SET Control **G**) and the coupling to the crystal mixers. Tuning procedures are given below.

(*c*) TUNING THE LOCAL OSCILLATOR. — The local oscillator has three tuning adjustments: TUNE SET Control **G** and TUNE Control **H**, located on the indicator panel, vary the repeller plate potential. The third adjustment varies the dimensions of the cavity built into the local oscillator tube by means of a tuning screw.

TUNE SET Control **G** is used to set the oscillator for maximum output. TUNE Control **H** (a vernier adjustment for TUNE SET Control **G**) is used to tune the oscillator over a small range.

The resonant frequency of the cavity is determined by its dimensions. TUNE SET Control **G** broadly sets the peak power output of the oscillator to correspond with the adjusted cavity frequency. The two adjustments are reactive to some degree, and several adjustments may be required to obtain optimum settings. Since this peak on the frequency-vs.-output curve is broad, small frequency adjustments can be made within the peak region by means of TUNE Control **H** without too greatly affecting oscillator output.

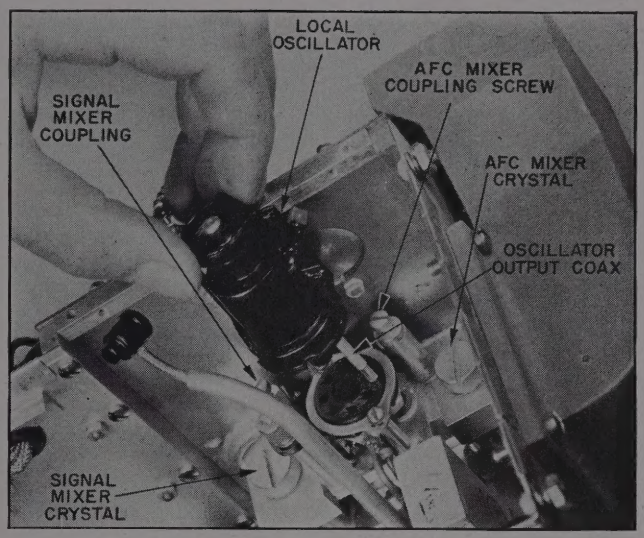


Figure 5-5—Replacement of Local Oscillator

When either the local oscillator tube or the magnetron has been replaced, it may be found that TUNE Control **H** has insufficient range to tune the Receiver properly or that the a.f.c. will not lock in reliably. In this event, the cavity must be adjusted.

This adjustment is made by rotating the small rectangular-headed machine screw near the top of the metal envelope. Clockwise rotation spreads apart two flat metal struts running along the axis of the tube, vertically compressing the cavity; counterclockwise rotation of the screw draws these struts together, vertically expanding the cavity. Since no mechanical stops are provided to limit the rotation of the tuning screw, the internal structure of the tube will be damaged if the flat struts are spread too far apart by clockwise rotation of the screw. Consequently, the tuning operation should be started with the screw turned to its counterclockwise limit. As tuning is critical, the screw should be turned slowly to avoid passing the resonance point before signals are observed on the PPI tube. Resonance will occur before the struts are pulled far enough apart to damage the tube. In fact, i.f. resonance both above and below signal frequency will be passed before the tube structure is in danger. The tube frequency is lowered as the struts are spread apart and the cavity is compressed. A relatively small rotation of the tuning screw covers the entire X-band with a slight overlap at either end.

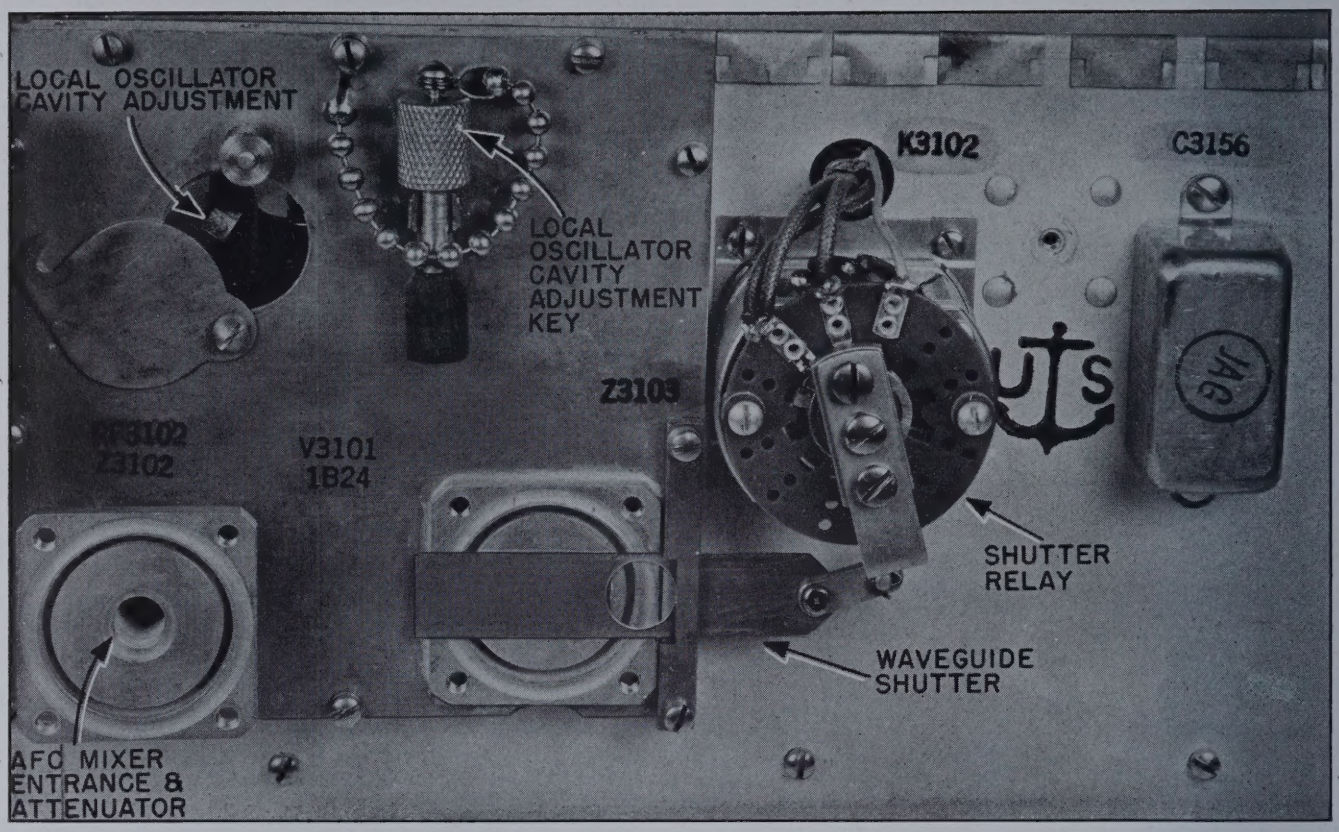


Figure 5-6—Receiver Input Assembly

(9) TUNING THE R.F. SYSTEM.

(*a*) TUNING PROCEDURE. — After replacing the magnetron, the local oscillator, or the entire Transmitter-Receiver Unit, it is necessary to retune the local oscillator, to check the mixer coupling (mixer current), and to retune the TR and ATR boxes.

Ordinary tuning of the local oscillator by adjustment of the panel controls is covered under *Operating Adjustments* in Sec. III. Broader tuning adjustments are explained under *Tuning the Local Oscillator* on page 5-9 and are included in the procedure below. The tuning of the TR and ATR boxes is also included in this procedure.

Tuning of the r.f. system should not be attempted until the equipment has been operating for 15–30 minutes. Furthermore, tuning should be done as rapidly as possible consistent with accuracy, since the removal of the receiver cover reduces the effectiveness of the magnetron blower motor, eventually causing the magnetron to overheat.

The tuning procedure follows:

1. With the Modulator turned off, open the transmitter-receiver and receiver cases. Connect a 0 – 10 milliammeter between J-3102 and ground.

2. With A.F.C.-MANUAL Switch 1 (located on the A.C.U.) set to "Manual" and TUNE Control **H** set to mid-scale, adjust TUNE SET Control **G** for maximum crystal mixer current as read on the milliammeter. With an insulated screwdriver, adjust the signal mixer current to 0.6 ma. by turning the fillister-head screw located on the Y-3101 side of the 723A tube.

Remove the meter lead from J-3102 and plug it into J-3103. Set the a.f.c. mixer current to 0.6 ma. by turning the other fillister-head screw (located on the Y-3102 side of the 723A tube) with the insulated screwdriver. Recheck both mixer currents as above. Remove the meter.

WARNING

A shell of the 723A is several hundred volts above ground. A screwdriver with an insulated shaft must be used for adjusting the mixer coupling to prevent short-circuiting the power supply. An insulated screwdriver and meter lead are supplied mounted on the receiver access door.

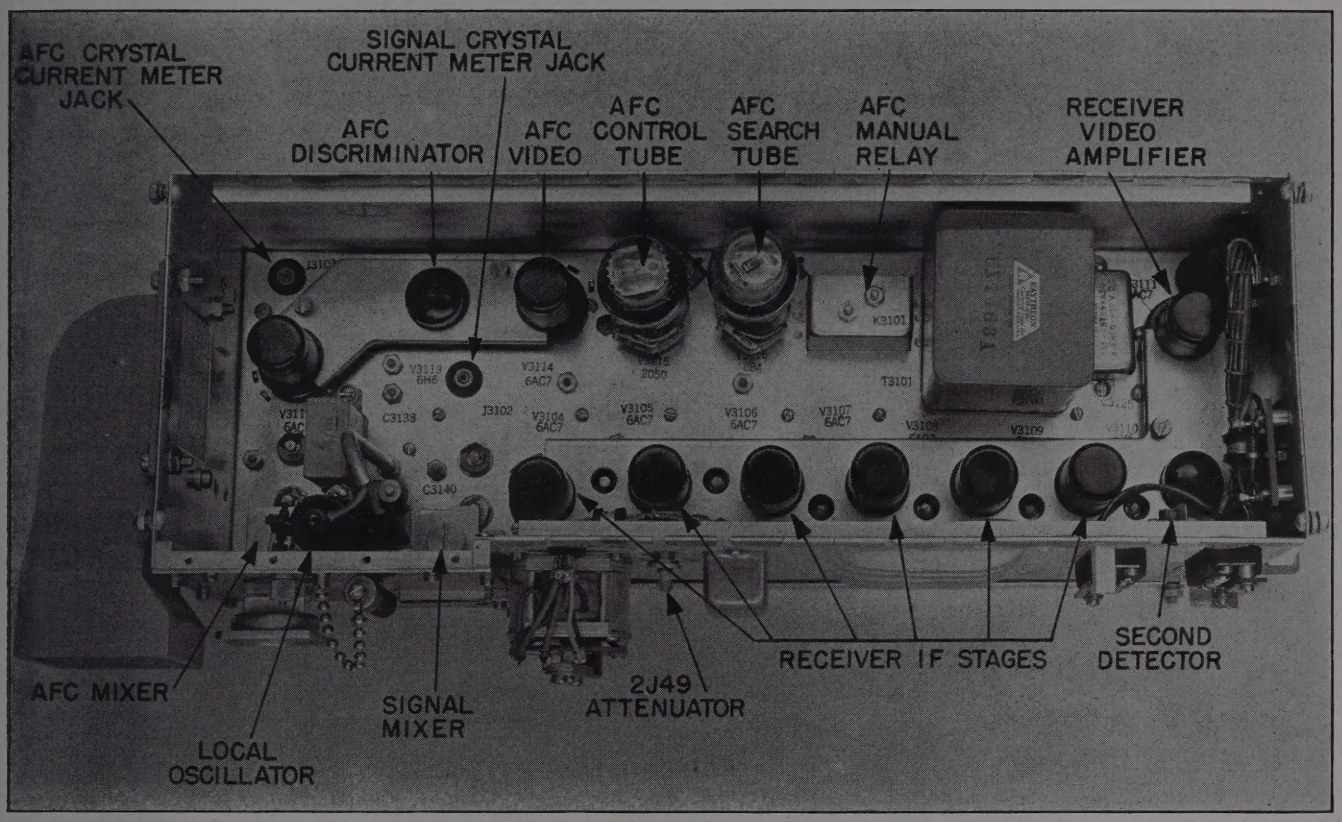


Figure 5-7—Receiver Unit: Top View with Cover Removed

3. Turn on the Modulator and set the A.F.C.-MANUAL Switch to "A.F.C." Slowly adjust the tuning screw on the local oscillator cavity by means of the attached tuning tool. The PPI sweep will flicker slowly until the correct cavity setting is reached, at which time the a.f.c. will lock in and signals will appear on the PPI.

4. Using a screwdriver, adjust the tuning screw in the top of the TR box (1B24) until the cavity is resonated, as indicated by maximum signal brilliance.

Note

Two small Allen setscrews will be found in the cavity at the sides of the tuning screw. These lock the tuning-screw bushing in place. Should the bushing bind the tuning screw, the assembly can be removed from the cavity and replaced by loosening the setscrews.

5. Set the A.F.C.-MANUAL Switch to "Manual." Slightly readjust the TUNE SET Control until signals appear, then slowly turn the cavity tuning screw two revolutions counterclockwise. If a second set of signals appears, peak the adjustment on these signals, leaving it at this point. If a second set of signals does not appear, return the adjustment screw slowly clockwise until signals are observed. (This technique is necessary to make sure that the local oscillator is tuned to the high-frequency side of the magnetron.)

6. Turn off the Modulator and reconnect the milliammeter to read crystal current. Set the TUNE Control to mid-scale and adjust the TUNE SET Control for maximum crystal current. If necessary, reset the two coupling screws between the local oscillator and the mixer crystals, as outlined in step (2).

7. Slowly turn the TUNE Control through its range. The receiver crystal current will rise from zero to a peak value of 0.6 ma. and then return to zero. Adjust the TUNE SET Control while rocking the TUNE Control back and forth until a reading of 0.1 ma. is obtained when the TUNE Control is turned an equal distance clockwise and counterclockwise from its mid-position. (See Fig. 5-8.)

8. Leaving the TUNE Control set at its mid-position, slightly adjust the local oscillator cavity for maximum signals. (These will not necessarily occur at the point of maximum crystal cur-

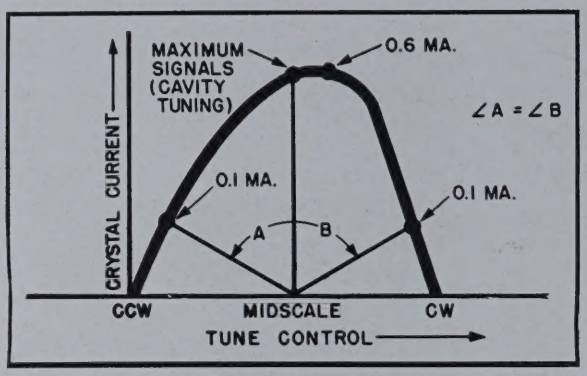


Figure 5-8—Effect of Tune Control on Local Oscillator Output

rent.) Recheck to make sure that the mid-position of the TUNE Control still falls equally between the two settings giving 0.1 ma. readings, as established in step (7). If necessary, readjust the TUNE SET Control to re-establish this condition. If this readjustment is made, the local oscillator cavity must be retuned for maximum signals at the mid-position of the TUNE Control, and the TUNE and TUNE SET Controls must be rechecked as above. As these adjustments are reactive and critical, they must be continued until the specified conditions are met.

9. Turn on the Modulator and adjust the TUNE Control through its range. Signals should appear only at the center of the range. If another set of signals is received, leave the TUNE Control adjusted at this point, and turn the cavity adjustment screw slightly counterclockwise until the undesired signals no longer appear within the range of the TUNE Control. Then return the TUNE Control to mid-position and adjust the TUNE SET Control for maximum signals. If necessary, also readjust the two mixer coupling screws as outlined in step (2), and then readjust the TUNE Control.

10. Compare the a.f.c. and manual tuning by throwing the A.F.C.-MANUAL Switch back and forth while observing signals. The signals should remain the same. With this switch at "A.F.C.," turn the TUNE Control slowly through its range. The signals should still remain the same.

11. Adjust the tuning plug on the ATR box until the cavity is resonated, as indicated by maximum signal brilliance, just as with the TR box.

Note

The tuning is very broad and the indication is not sharp. However, certain settings of the tuning plug will decrease the signal brilliance noticeably, and such settings must be avoided.

12. Replace the receiver and the transmitter-receiver access doors.

Note

The a.f.c. circuit is now tuned to search over an equal range on each side of the frequency to which the local oscillator is tuned on "Manual." The TUNE SET Control is now adjusted so that maximum signals are received in the center of the local oscillator frequency curve (see Fig. 5-8). Since this curve is not always symmetrical, maximum crystal current does not necessarily occur at the point of maximum signals.

A local oscillator tube which has a mode wider than 60 Mc. can cause the a.f.c. to lock in on the low side of the magnetron frequency instead of on the high side as normally. If locking in occurs on the low side, it will be at a frequency detuned from the intermediate frequency.

Since, however, the locking in on the low side is imperfect (as explained on page 4-11), this type of operation is not satisfactory. For this reason the lower-side band is deliberately tuned off the mode (on tubes where this condition exists), so that there is no output in that frequency. As a result, the a.f.c. will not lock in at the lower frequency but will continue searching until it finds the desired frequency on the high side of the magnetron.

(*b*) ADDITIONAL TUNING CHECK. — When a vacuum-tube voltmeter is available an additional tuning check may be made if desired. The procedure follows:

1. Connect a vacuum-tube voltmeter (250-volt scale) with its positive lead to ground and its negative lead to the repeller plate of the local oscillator tube.

2. With the A.F.C.-MANUAL Switch at "Manual," adjust the TUNE Control until signals are received, and note the voltage at that setting. Return the A.F.C.-MANUAL Switch to "A.F.C." The voltage should remain the same. Turn the Modulator off. The repeller voltage should search over a range of approximately 80 volts, as read on the meter, and over an approximately equal range on each side of the voltage at which maximum signals are received.

3. Disconnect the meter, and replace the receiver access door. With the TUNE Control ad-

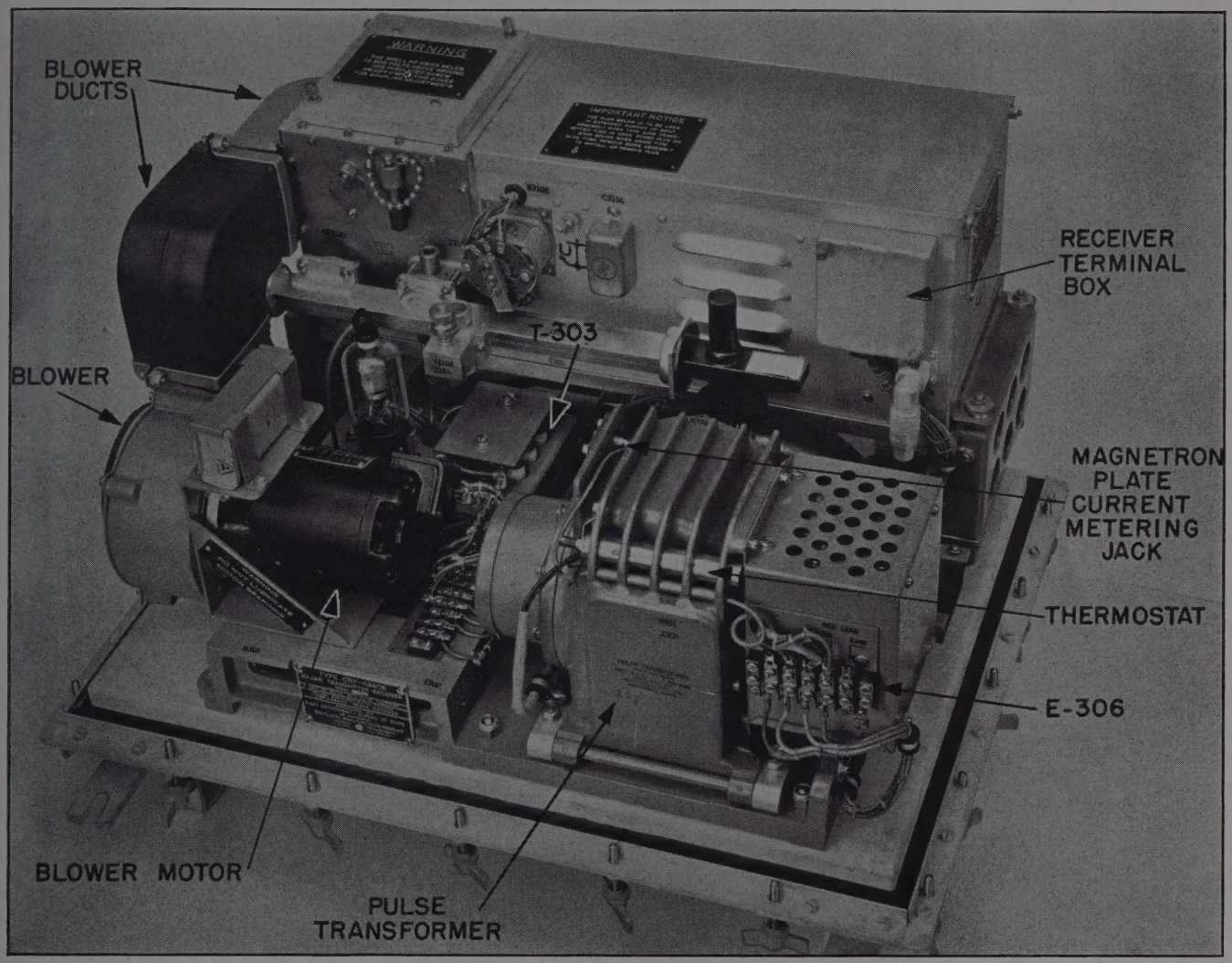


Figure 5-9—Transmitter-Receiver Unit: Cover Removed

justed for maximum signals when the A.F.C.-MANUAL Switch is at "Manual," and with the latter switch then thrown to "A.F.C.," the a.f.c. circuit should lock in each time the Modulator is turned off and then on.

(10) BLOWER MOTOR. — The blower motor for cooling the magnetron in the Transmitter Unit is permanently oiled and requires no further lubrication.

Every three months the motor should be inspected and its brushes replaced. The brushes are $\frac{5}{8}$" long when new, the minimum usable length being $\frac{5}{16}$".

When the bearings are worn out or the commutator is badly pitted, the motor should be replaced.

Normal blower motor current is 1 amp.

The life of the motor is about 600 hours. After this period, the motor is not reliable.

e. RECTIFIER POWER UNIT.

(1) REMOVAL OF CHASSIS.

(*a*) Disconnect all external leads and carefully bend the cables down out of the way.

(*b*) Remove the ground lead on the lower left side of the chassis.

(*c*) Hinge down the chassis. Remove the screw on the stop link within the case in the middle of the left side.

(*d*) Remove the two hinge bolts outside the case on the lower left and right sides. The chassis is now free to be lifted out.

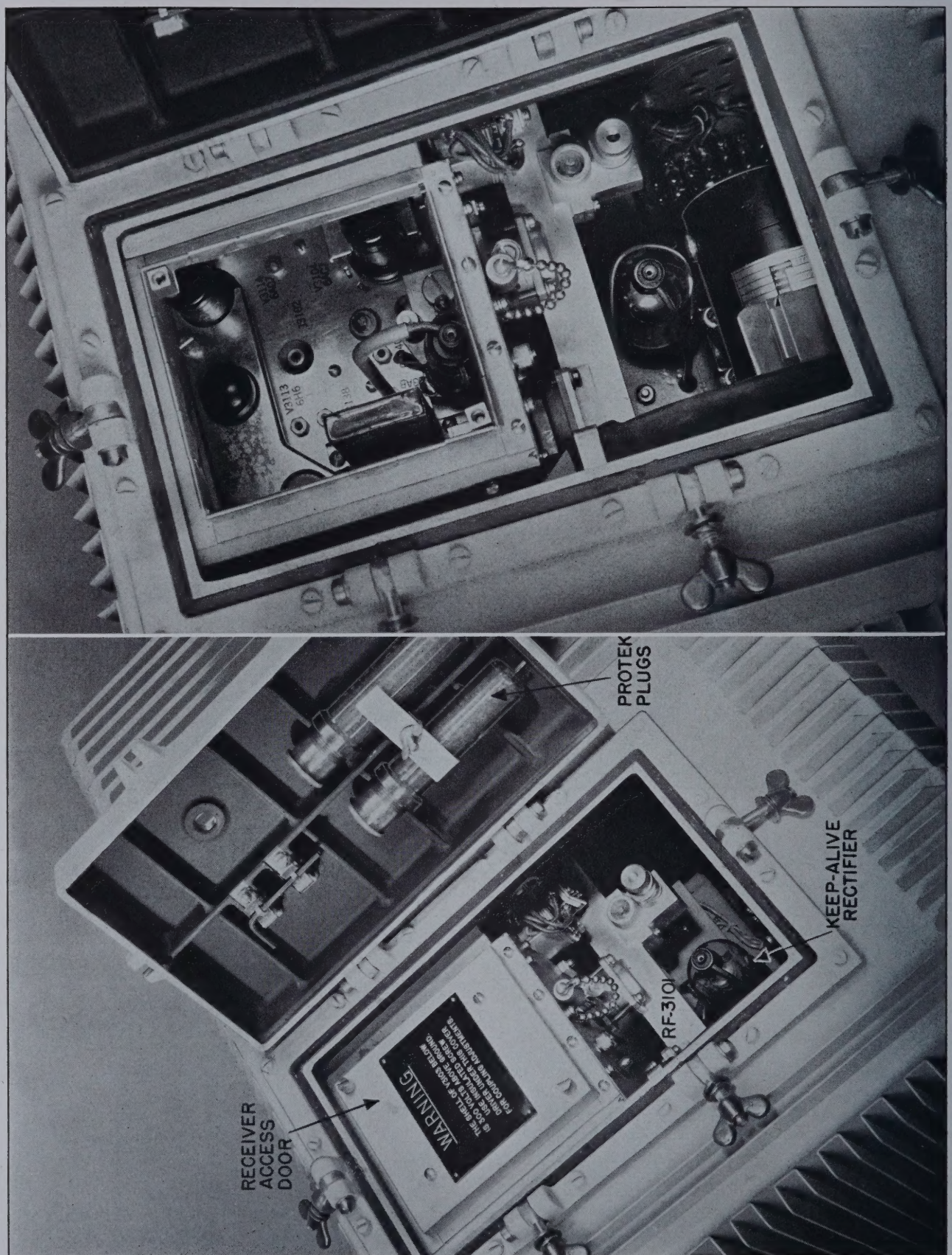


Figure 5-10—Transmitter-Receiver Unit: Access Doors Open

(2) REINSTALLATION OF CHASSIS. — To reinstall the chassis, reverse the procedure given for removal.

(3) SERVICING CHASSIS IN PLACE.

(*a*) To gain access to the antenna relays, loosen the two screws on the terminal panel and hinge down this panel.

(*b*) To gain access to the transformer terminals and potentiometers R-211 and R-219, loosen the two screws on the top side of the fuse panel and hinge down this panel.

Note

To test the chassis while the cover is off, the Battle Switch must be thrown to the "On" position.

(4) ADJUSTMENT OF VOLTAGE REGULATORS. — Voltage controls R-211 and R-219 are located between the large resistors on the resistor fuse panel of this unit. Potentiometer R-211 should be adjusted to give 300 volts as measured between terminals 33 and 31 with the equipment operating normally. R-219 should be adjusted to give 300 volts as measured between terminals 47 and 50. Variation of primary voltage to T-202 and T-203 over a range of ±10 volts should not appreciably change the output from 300 volts.

(5) ADJUSTMENT OF D.C. OUTPUT. — The output of the Receiver and Indicator supplies should be set to the value indicated on the circuit schematic. These adjustments are made by means of controls R-205 and R-219 located on the fuse panel.

The D.C. voltage of the selenium rectifier should be checked once a month, after a warming-up period of one-half hour. If the voltage has fallen

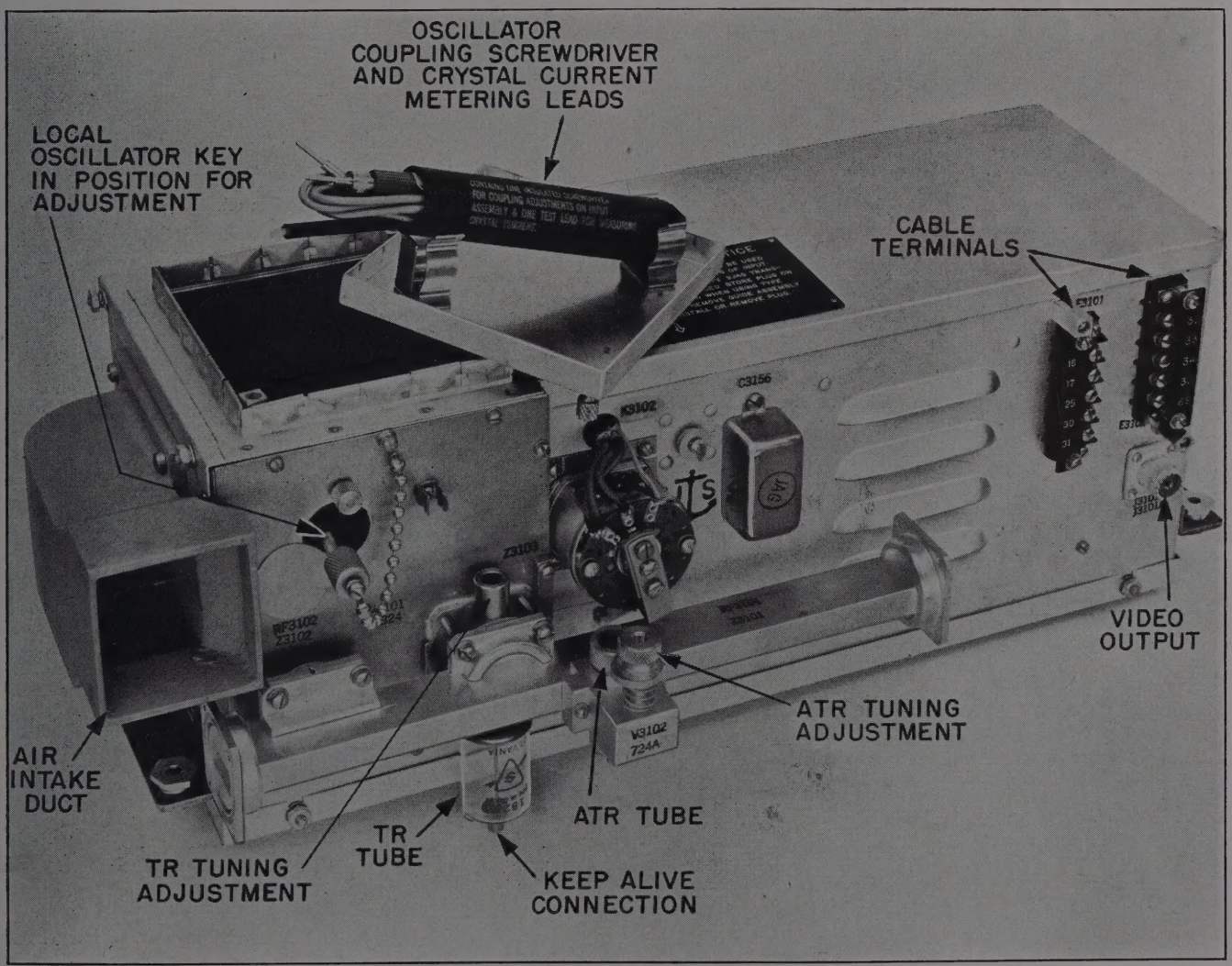


Figure 5-11—Receiver Unit: Tuning Adjustments

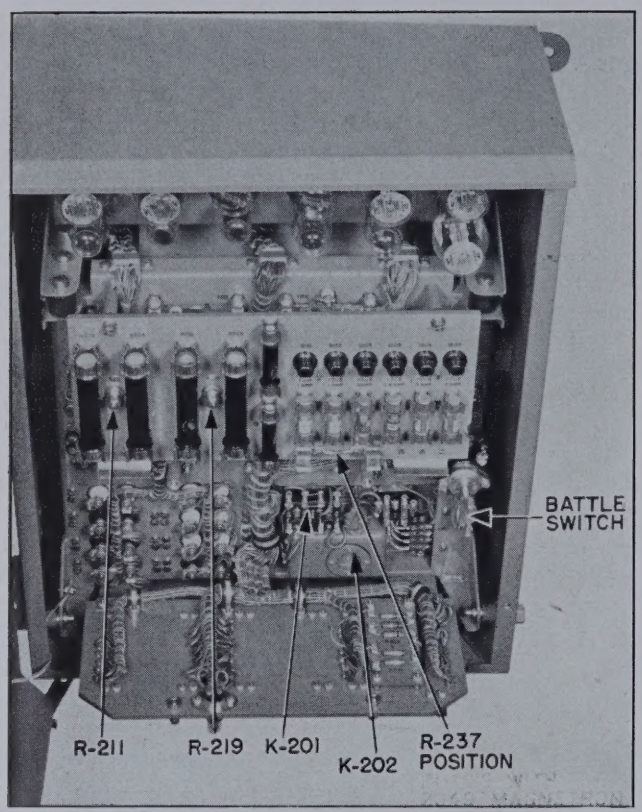


Figure 5-12—Rectifier Power Unit: Terminal Panel Lowered

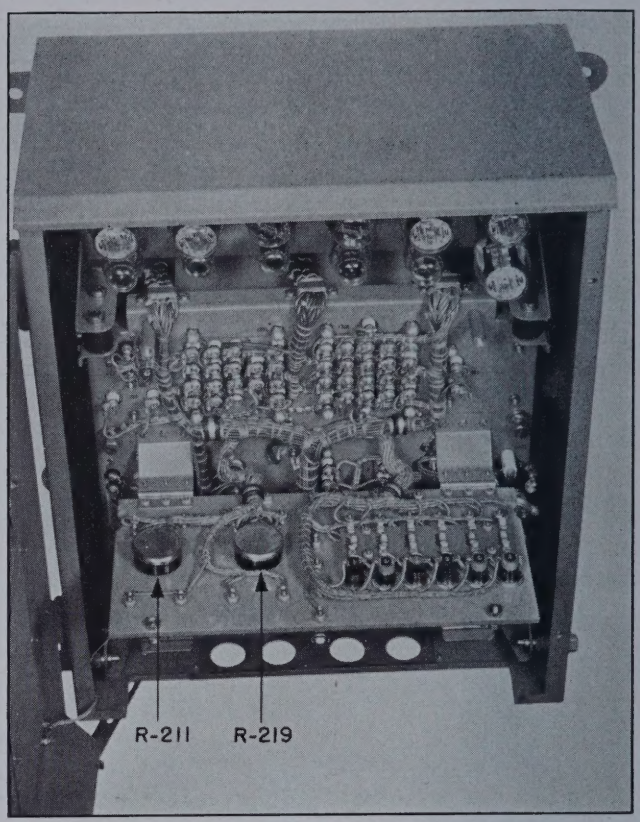


Figure 5-13—Rectifier Power Unit: Fuse and Resistor Panel Lowered

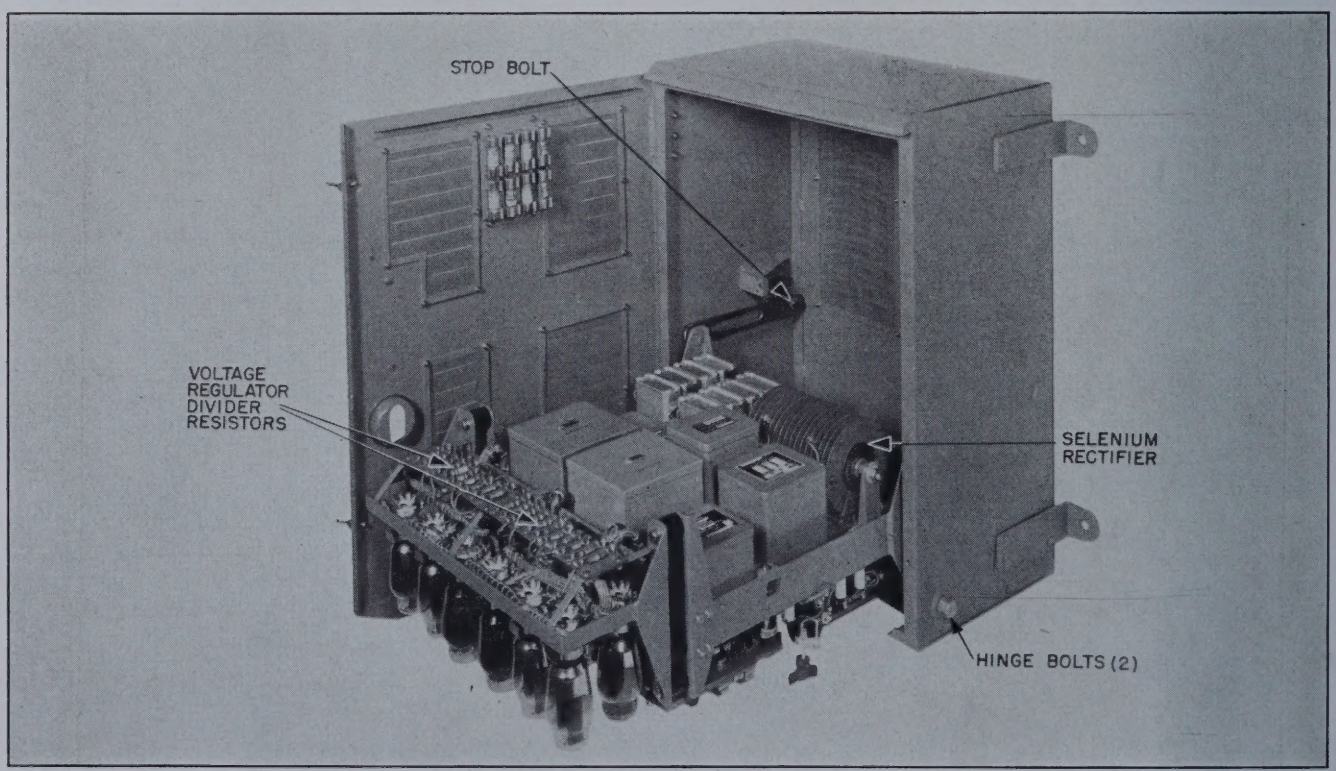


Figure 5-14—Rectifier Power Unit: Entire Chassis Lowered

to the neighborhood of 22 volts, the movable lead should be changed to a higher tap.

To provide stabilization of the d.c. control voltage within the optimum range of 22—30 volts, the power transformer has three taps (numbered in the order of increasing voltage), permitting the use of rectifiers of different characteristics and ages. New G.E. rectifiers are normally connected to tap #1, old G.E. and new Federal rectifiers to tap #2, and old Federal rectifiers to tap #3.

If the voltage is still too low when the highest tap is used, the rectifier should be replaced from spares. If the replacement rectifier is of a different make having a different arrangement of terminals, proper polarity must be observed when reconnecting the leads.

f. JUNCTION BOX. — This unit is mounted in a watertight box, which is opened by loosening the captive screws and hinging back the cover. When closing the cover, all captive screws must be well tightened to prevent leakage.

Little maintenance should be required. The dehydrator plugs should be inspected once a month and replaced when found to be exhausted. (See "Dehydrator Plugs," near the end of this subsection.) During this inspection the contacts on relays K-1301 and K-1302 should be burnished, and plate voltage control relay K-1304 should be inspected and checked for proper operation.

WARNING

Do not inspect or service this unit with power applied unless absolutely necessary. No safety interlock or battle switch is provided. Although the voltages encountered do not exceed 115 d.c., such voltages can be dangerous under certain conditions.

g. PLAN POSITION INDICATOR.

(1) REMOVAL OF CHASSIS.

(*a*) Loosen the captive thumbscrews around the edge of the panel (see Fig. 3-1).

(*b*) Lift up the locking lever located on the right side of case and pull out the chassis.

(*c*) To service the chassis while operative, connect between J-401 and P-401 the test cable packed in tender spares.

(2) REINSTALLATION OF CHASSIS.

(*a*) First make sure that the locking lever is up, then slide the chassis into its case until it strikes the latch.

(*b*) Press down the locking lever and secure the captive screws.

(3) INSTALLATION OF NEW UNIT. — When the whole Indicator must be replaced, it is best to remove the terminal box housing J-401 from the old unit and install it complete with cabling on the new unit. Make sure that all seals are watertight.

(4) REMOVAL OF PPI SUBASSEMBLY.

(*a*) First remove the Indicator chassis as previously outlined in this subsection.

(*b*) Unscrew the dehydrator plugs from the subassembly.

(*c*) Remove the plate lead from its terminal on the flare of the PPI tube.

(*d*) Remove the two wing nuts on jack board J-402 and disconnect plug board P-402 from J-402 (see Fig. 5-17A).

(*e*) Loosen the four screws holding the subassembly to the indicator chassis, and vertically lift out the subassembly (see Fig. 5-17B).

(5) PPI TUBE.

(*a*) REMOVAL.

1. Remove the PPI subassembly as previously outlined.

2. Remove the #4 *nuts* (not screws) holding the bearing indicator dial to the PPI sub assembly. *Do not remove the dial rollers.*

3. Lift off the bearing vane and dial assembly (see Fig. 5-17C).

4. Grasp the front edge and the tapering section of the PPI tube, using both hands, and cautiously work the tube loose from its socket. Carefully withdraw the tube from the assembly (see Fig. 5-17D).

(*b*) INSTALLATION. — Reverse the above procedure, making sure that the tube base key is properly aligned.

(*c*) CHECK-UP FOLLOWING INSTALLATION.

1. With the indicator chassis replaced in its case, start the equipment and adjust FOCUS Control **O** until the sweep is sharp. If this cannot be done, refer to step (8) and *Adjusting the Focus.*

2. With the Antenna rotating, adjust CENTER Control **P** until the start of the sweep describes a small circle.

3. Check the centering of the bearing cursor by observing both ends of the cursor when the indicating end is set first to 0° and then to 90°.

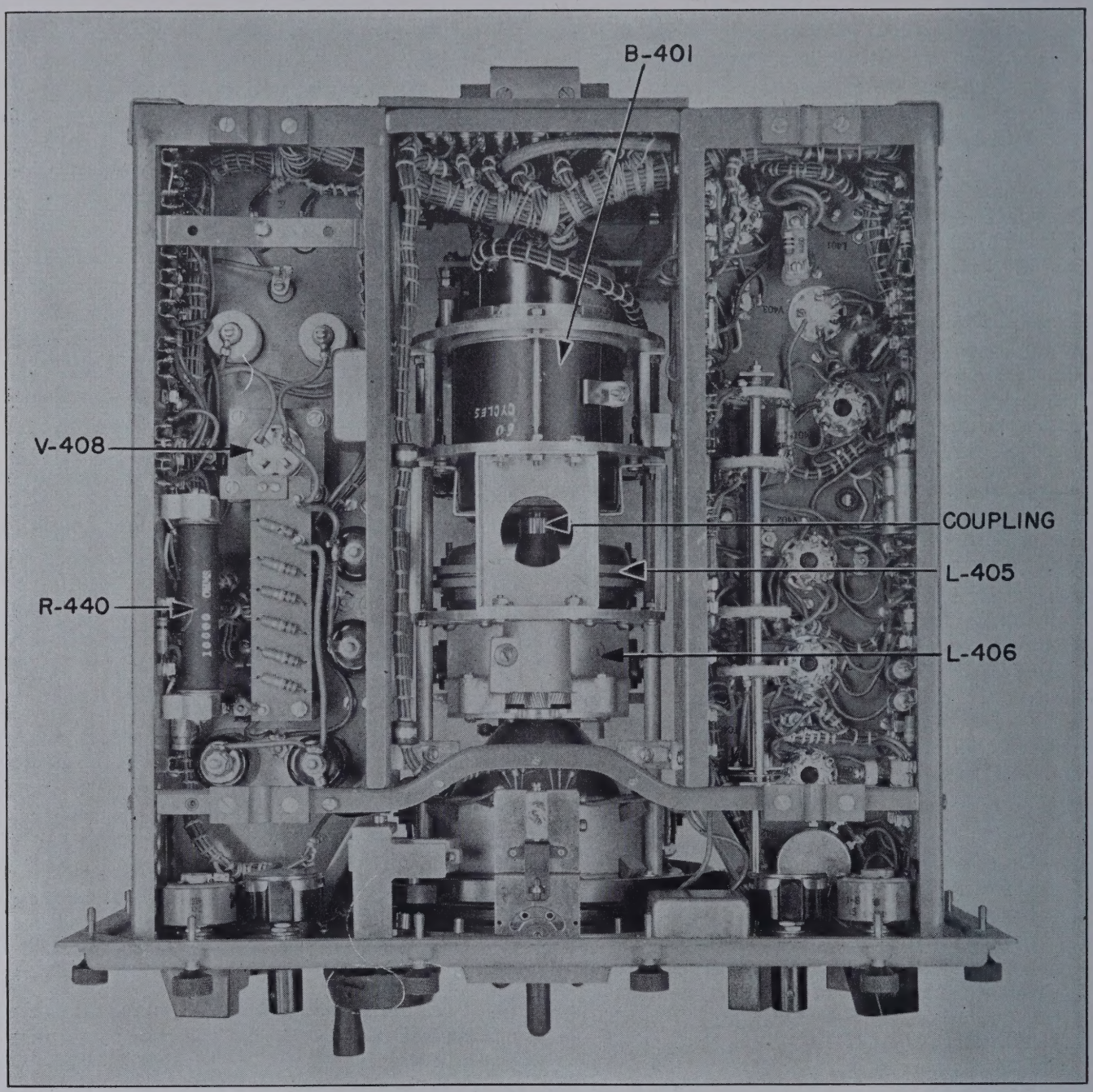


Figure 5-15—Plan Position Indicator: Underside of Chassis

At the 0° setting the opposite end should read exactly 180°; at the 90° setting the opposite end should read exactly 270°. If such is not the case, refer to step (8) and *Adjusting the Cursor Assembly*. When the cursor is centered it may be used as outlined below for checking the centering of the PPI spot.

Note

The cursor must be properly centered before the sweep centering can be accurately checked.

If a more careful check of centering is needed, the readings can be checked at 45° intervals around the dial. In all cases opposite ends of the cursor should be exactly 180° apart.

4. With the equipment operating, stop the sweep near 0°. Set the cursor over the sweep line and exactly parallel to it.

5. By sighting along the cursor, determine whether or not the sweep is exactly behind

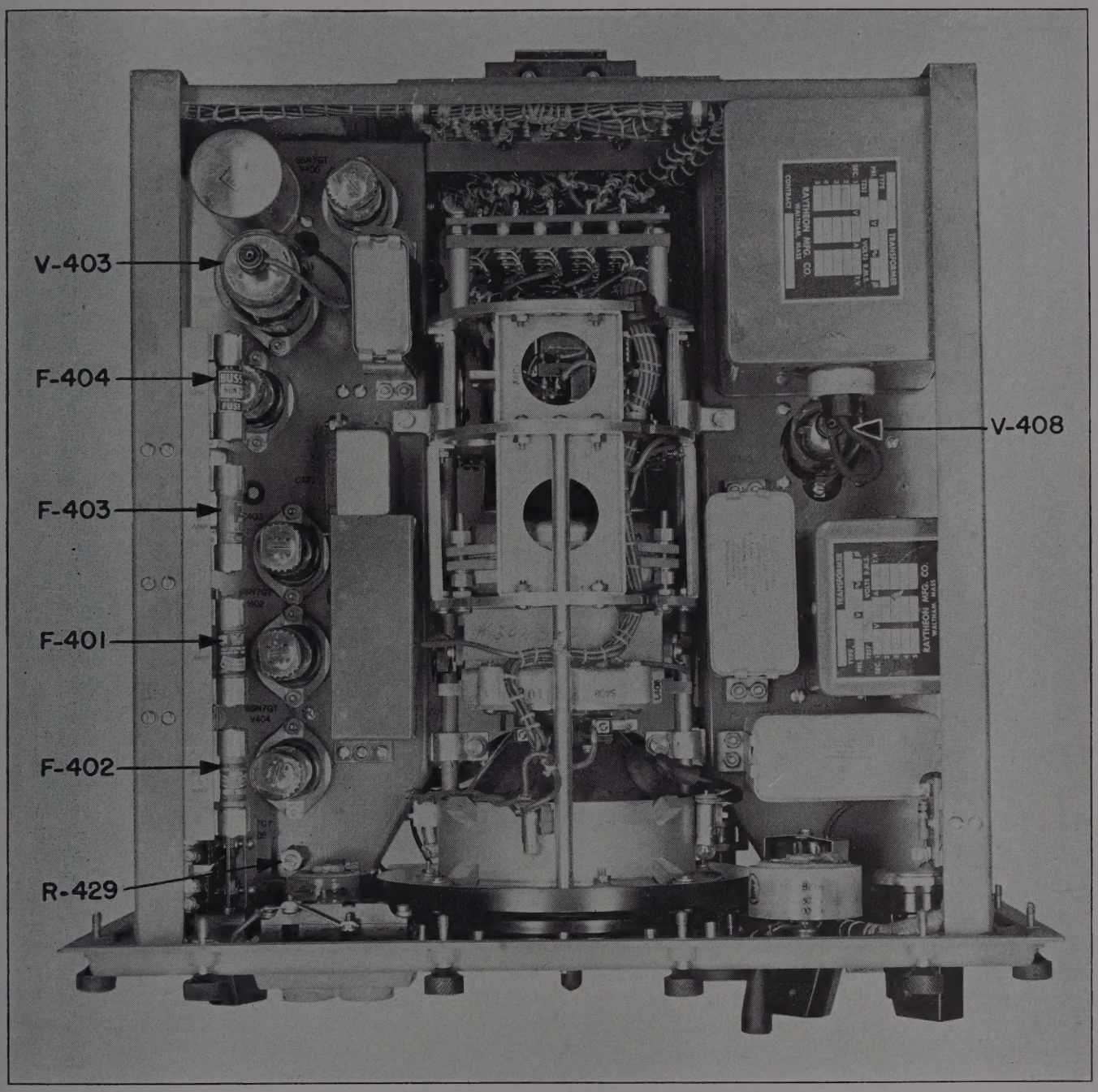


Figure 5-16—Plan Position Indicator: Top View of Chassis

the cursor or on one side of it. To avoid parallax, be sure the line of sight is parallel to the wide edge of the cursor.

6. Shift the sweep to the 90° position, align the cursor, and sight along the cursor as before.

If in both cases the sweep was directly behind the cursor, the sweep is properly centered; if, however, the sweep was on one side or the other, refer to step (8) and *Adjusting the Sweep Centering*.

7. Check the rotating cursor assembly for play in the rollers, which would cause bearing errors. If play is found, refer to step (8) and *Adjusting the Cursor Assembly*.

8. If the focus, sweep centering, and cursor centering are now correct, the installation is completed. If, however, the sweep centering is *not* correct and/or the focus cannot be properly set by means of FOCUS Control **O**, withdraw the indicator chassis from its case and install the indicator test

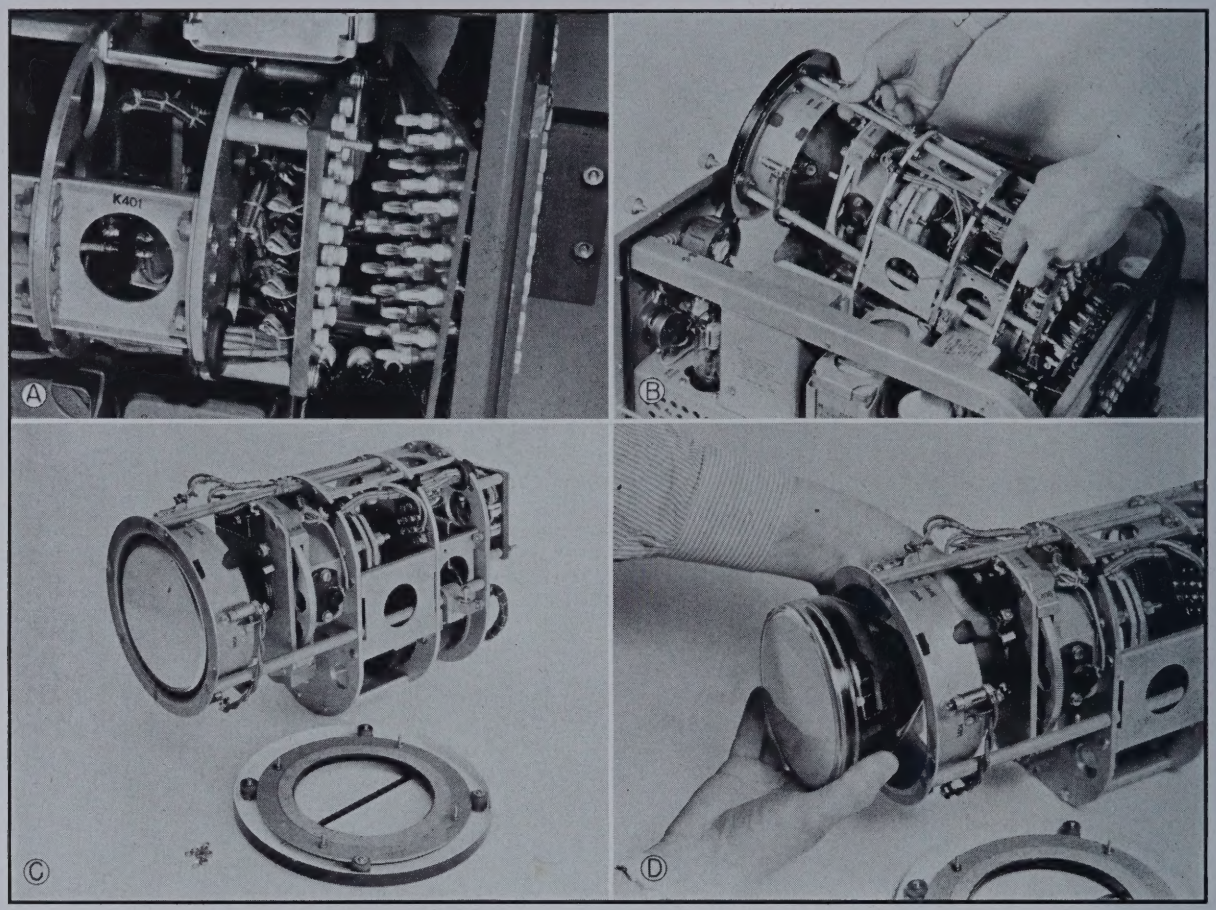


Figure 5-17—Replacement of PPI Tube

cable found in spares. Then, with the equipment operating, refer to the applicable subsections below.

(*d*) ADJUSTING THE FOCUS. — Failure of the tube to focus properly after replacement occurs when variations in individual tube characteristics exceed the range of FOCUS Control **O**. Tubes which give this trouble are outside the original manufacturers' tolerances.

The trouble must be remedied by selecting a tube whose characteristics are within the required tolerances.

(*e*) ADJUSTING THE SWEEP CENTERING. — The centering of the sweep is controlled by adjusting the position of the focus coil.

1. Loosen the focus coil locks and shift the coil position in the required direction, by prying the coil mount in older Indicators, or by shifting the coil mount by the two top jack studs in later Indicators.

2. Check the sweep centering as in steps (4), (5), and (6) under *Check-Up Following Installation*. Repeat the centering adjustment as required. As a final check on proper centering, make the centering test at 45° intervals throughout the 360° of rotation. If, however, it is impossible to center the sweep at every point on the bearing dial, the probable cause is a defective deflection coil.

(*f*) ADJUSTING THE CURSOR ASSEMBLY.

1. Remove the PPI subassembly from the indicator chassis.

2. Slightly loosen the screws (on the cursor face) holding the rollers in place. Turn the roller shafts, using a screwdriver in the slots at the rear of the rollers. Take up the slack evenly by adjusting all three rollers together.

3. After completing the adjustment, hold a pencil rigidly near the rim of the cursor ring and

rotate the ring by hand. If the ring is seen to rotate off-center, readjust the eccentrics until the ring runs true and all play is eliminated.

(6) BEARING CURSOR (VANE). — The pressure between the cursor wheel and the rubber roller of the bearing crank will decrease as the roller wears, causing slippage. An eccentric take-up adjustment is provided by the use of an off-center shaft hole in the panel bushing. The desired pressure between the roller and the dial is obtained by loosening the nut on the panel and rotating the eccentric bushing as required. Excessive pressure will spring the cursor wheel and may jam the cursor mechanism (see Fig. 5-15).

Later-type Indicators have a spring-loaded gear drive which requires no adjustment.

(7) DEFLECTION COIL DRIVE GEARS. — These gears are designed to run dry and should never be lubricated (see Fig. 4-17). The small pinion gear is mounted in an adjustable eccentric bushing to provide for proper meshing of the gears. The small gear shaft and the deflection coil bearings should be oiled quarterly with a few drops of Univis P-48.

(8) MULTIVIBRATOR BIAS ADJUSTMENT. — Before making initial tune-up adjustments it is sometimes necessary to set the square-wave multivibrator bias on the Indicator. This adjustment is performed at the factory and will usually be found correct. Should unstable sweeps or double range marks be encountered, however, improper adjustment of the bias is a possible cause. Bias Control R-429 is located on the indicator chassis in the left front corner (see Fig. 5-16).

To adjust this control, proceed as follows:

(*a*) Remove the Indicator from its case and install the indicator test cable found in tender spares.

(*b*) Start up the equipment *but do not press the START Button on Switch* **B**, *which would start the Modulator*. Allow the equipment to warm up for a few minutes, then adjust INT Control **M** to about half-scale.

(*c*) Set Range Switch **J** to "80" and adjust R-429 until the multivibrator self-triggers and sweeps appear on the PPI.

(*d*) Retard R-429 slightly more than is necessary to cause the sweeps to disappear.

(*e*) Turn Range Switch **J** back and forth several times. If sweeps reappear on any range, readjust R-429 slightly until they disappear.

(*f*) Press the START Button on Switch **B**. Proper triggering of the multivibrator by the Modulator will be indicated by stable sweeps.

(*g*) Remove the test cable and replace the Indicator in its case.

h. ACCESSORY CONTROL UNIT.

(1) REMOVAL AND REPLACEMENT. — Procedures are the same as for the Indicator.

(2) SERVICING. — For servicing the chassis while operative, the test cable can be connected between J-701 and P-701. However, the coaxial input cable to the echo box tuning amplifier will still remain disconnected.

(3) TROUBLE-SHOOTING NOTES. — If the movable range mark does not appear on the PPI screen, the A.C.U. ranging system is not functioning. Unsteady motion of the movable range mark when the hand-crank is turned, or erratic range indications, may be caused by slipping of the ranging potentiometer drive mechanism or slipping between the potentiometer and the dial. Jumping of the range mark when the crank is turned may be caused by a defective or dirty contact on the range potentiometer.

i. ANTENNA ASSEMBLY.

(1) ROUTINE MAINTENANCE. — Conscientious routine lubrication is necessary because the factory alignment of the rotary waveguide joint must be kept within close tolerances in order to prevent overloading of the antenna drive motor. The Antenna Assembly is lubricated at the factory. All parts so designated on nameplates require monthly lubrication with Navy type OS-1350 lubricant or equivalent. The rotary waveguide joint should be oiled monthly with the same lubricant.

The waveguide crook which terminates in the nozzle is anchored below the crook on an adjustable bracket. The adjustments are set at the factory and must be kept tightly locked. Any appreciable movement of the crook may, besides causing mismatch, overload the motor drive by misaligning the rotary joint. (The joint also serves as a sleeve bearing to align the fixed and rotating portions of the waveguide.) If the rotary joint, spindle sleeve bearings, or gears are allowed to bind, the drive motor armature current will rise above its safe maximum limit.

(2) WAVEGUIDE. — The waveguide does not require the careful maintenance and periodic inspection of a gas-filled coaxial line. Low sensi-

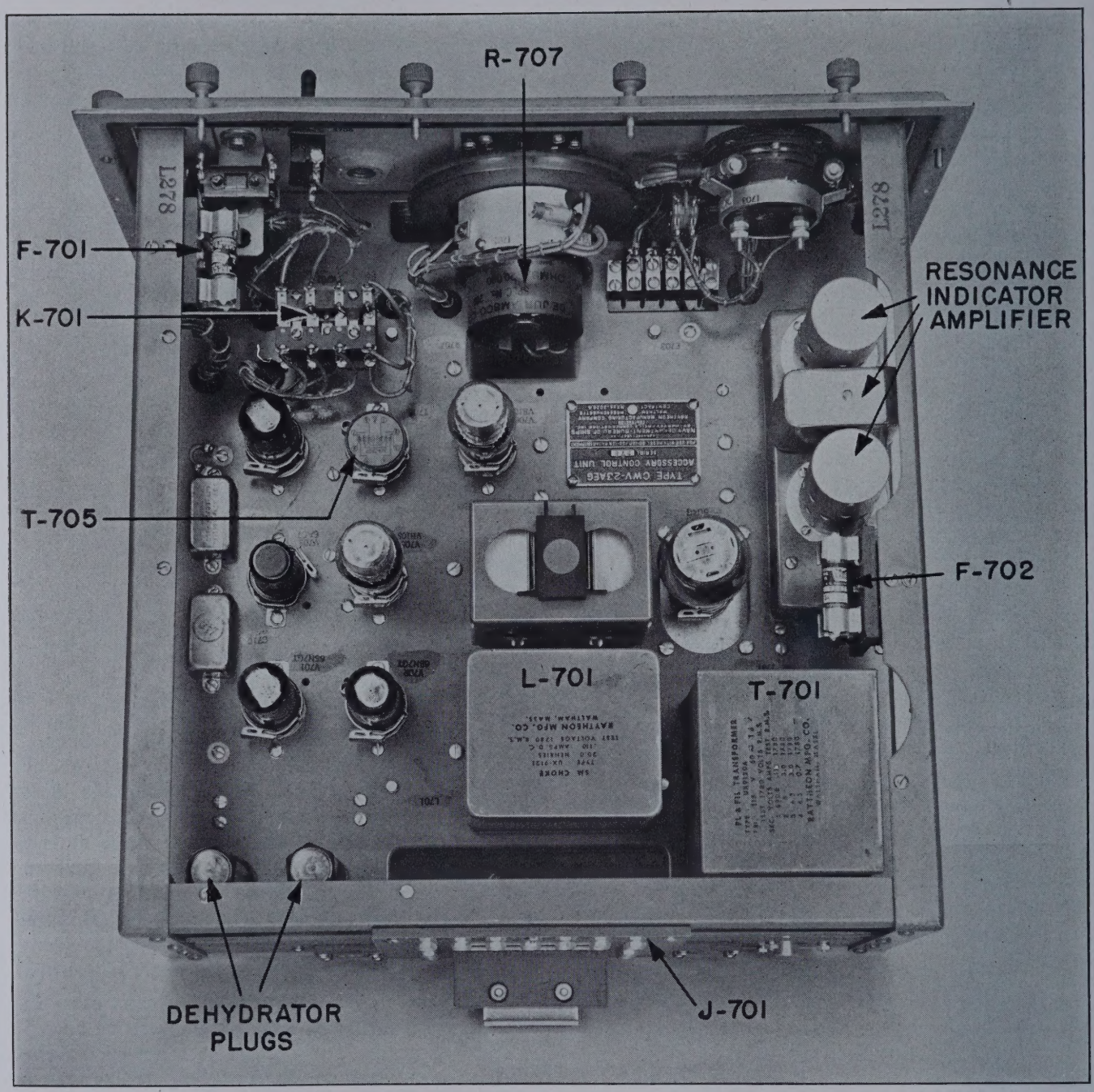


Figure 5-18—Accessory Control Unit: Top Rear View of Chassis

tivity, however, has sometimes been traced to water, metallic scale, dirt, etc., in the waveguide.

Since the waveguide is not gas-filled, water often forms through condensation. This water tends to collect at the bottom of the guide, causing erratic operation. It should be removed by taking off the water trap on the bottom of the waveguide section near the Transmitter, and draining and wiping out the trap. When metallic scale is present, it often shows up as audible arcing within the waveguide. If this occurs, the waveguide should be cleaned, and if any scale still remains, the waveguide should be replaced. Should water traps (low places) be present in the waveguide run, a $\frac{1}{32}$" or $\frac{3}{64}$" hole may be drilled on the center of the wide side at its lowest point, or two such holes may be drilled 1" apart along the guide. If preferred, a slot of any desired length may be cut along the guide $\frac{3}{64}$" each

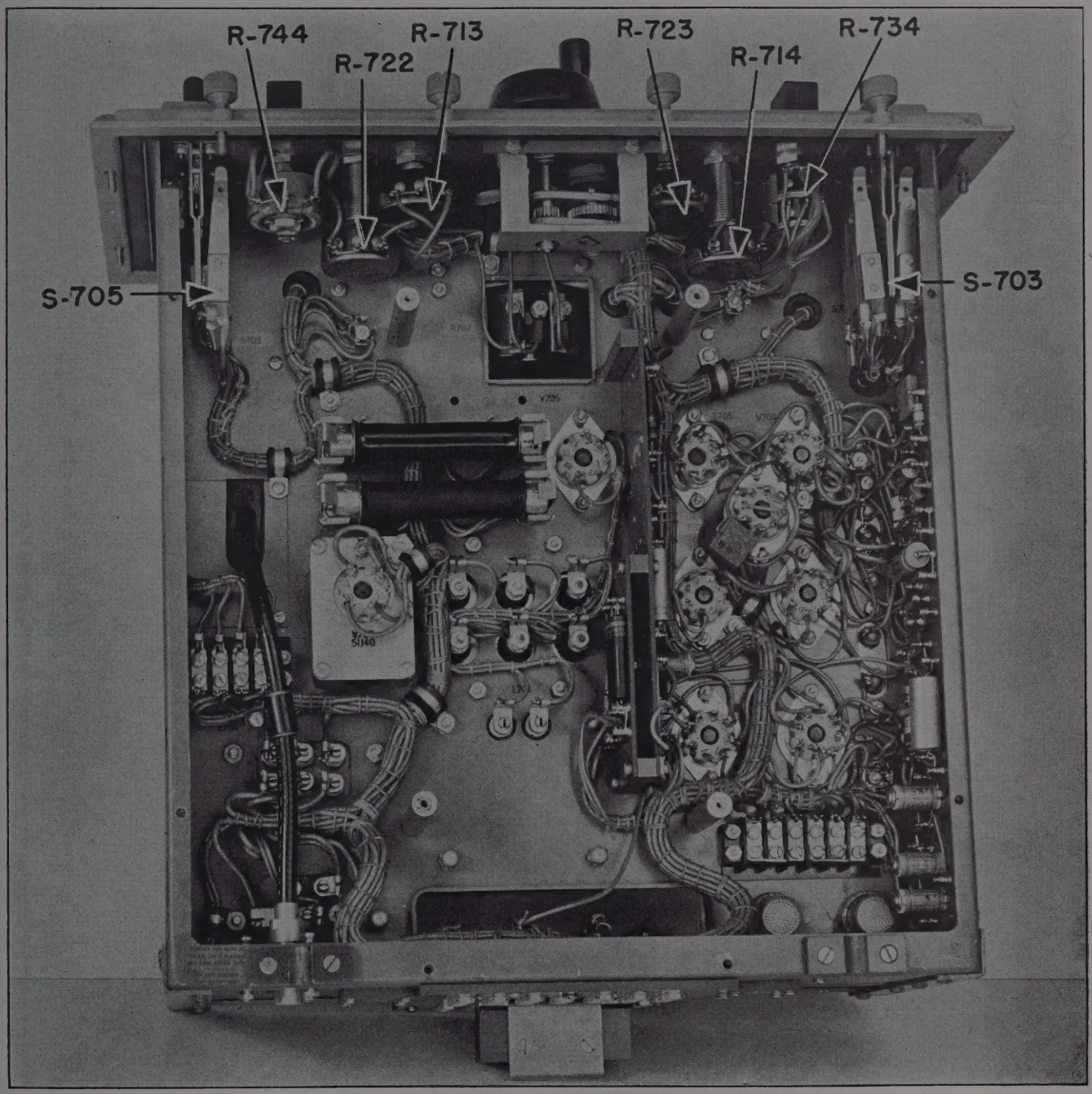


Figure 5-19—Accessory Control Unit: Underside of Chassis

side of center (total width of slot 3/32"). After drilling, all burrs must be removed from inside the guide.

(3) ALIGNMENT OF SYNCHRO SYSTEM. — Alignment is required after the completion of a new installation or major repairs of the Antenna. Alignment should never be attempted unless it is known to be necessary. *It should be performed only by personnel thoroughly familiar with the equipment.*

(*a*) Make sure that the equipment is completely turned off. Disconnect the ship's gyro compass by removing the lead from terminal R15 on E-1416 in the Bearing Control Unit.

(*b*) Remove the antenna cover plates. Manually rotate the Antenna by means of the knurled thumbscrew on the motor shaft until the Antenna points exactly to the ship's bow.

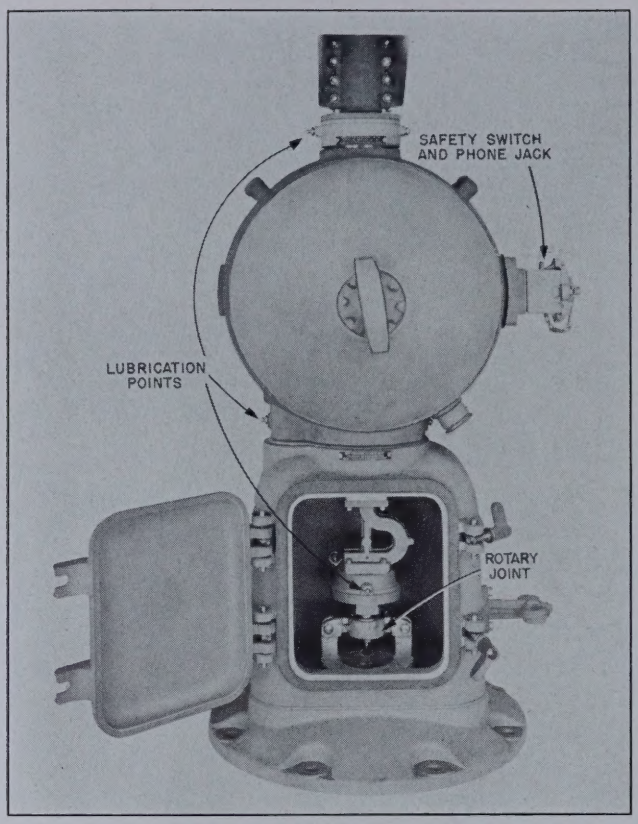


Figure 5-20—Antenna Pedestal and Gear Housing

(*c*) Adjust the flasher cam in the Antenna until the cam edge nearest the switch assemblies just operates the single-pole double-throw micro-switch. To do this, loosen the band clamp and slip the cam around to the correct position. (The rest of the cam should lie beyond, not between, the micro-switch rollers.) Tighten the band clamp.

(*d*) Adjust the antenna synchro cam so that the roller rests on the exact center of the cam, by slipping the band clamp as in step (*c*). (The synchro cam engages a single micro-switch below the flasher micro-switches.)

(*e*) In the Bearing Control Unit engage both cams of S-1408 and S-1409 by rotating the gearing.

(*f*) Lock the step motor by tightening the wing nut on the end of the gear housing.

(*g*) Engage the sweep coil cam in the Indicator.

(*h*) Turn on the equipment and allow it to warm up for several minutes.

(*i*) If the PPI sweep is not on zero, loosen the three clamping screws on the body of the 5DG synchro in the Bearing Control Unit. Turn the synchro case until the PPI sweep is on zero. (Both cam rollers in the Bearing Control Unit should now be at the exact centers of their cams.)

(*j*) Tighten the clamping screws on the 5DG synchro.

(*k*) Rotate the Antenna several times in both directions to make sure that the PPI sweep locks in and keeps in step with the Antenna.

(*l*) If the ship heading flasher is not exactly on zero, adjust the antenna flasher cam as needed.

(4) ROUTINE ALIGNMENT CHECK.

(*a*) Turn off the equipment, move the large gear driven by the 1F synchro at least 36° in either direction, then move the PPI sweep coil at least 36° in either direction.

(*b*) Turn on the equipment and rotate the Antenna several times (two revolutions are sufficient to establish synchronism). Check the alignment.

(*c*) Unlock the step motor and rotate slowly, observing the heading flash on the PPI screen and making sure that the sweep follows without losing synchronism. (If the step motor is turned to give an equivalent bearing change of more than 36° before the Antenna makes one revolution, the Antenna will make one revolution before establishing synchronism.)

(*d*) If the alignment and operation check satisfactorily, the mechanical differential in the Bearing Control Unit should now be released or locked so as to provide true- or relative-bearing operation, as desired. The procedure follows:

(5) ALIGNING THE SYNCHRO SYSTEM FOR TRUE BEARING.

(*a*) With the ship's gyro disconnected from the Bearing Control Unit, turn the step motor until the heading flash agrees with the ship's heading.

(*b*) Reconnect the ship's gyro to the Bearing Control Unit by replacing the lead to terminal R15 on E-1416. (The step motor may be turned after it is energized in case the ship's heading changes during calibration.)

(*c*) Have the ship's gyro precessed in both directions and check the heading flash for agreement. If the heading flash indicates wrong rotation, reverse the leads on terminals R11 and R13.

(6) LOCKING THE DIFFERENTIAL FOR RELATIVE BEARING.

(*a*) Disconnect the gyro lead from terminal R15 on E-1416 in the Bearing Control Unit.

(*b*) Turn the step motor until the heading flash occurs exactly at 0° on the PPI dial, then lock the step motor with the wing nut on the gear housing.

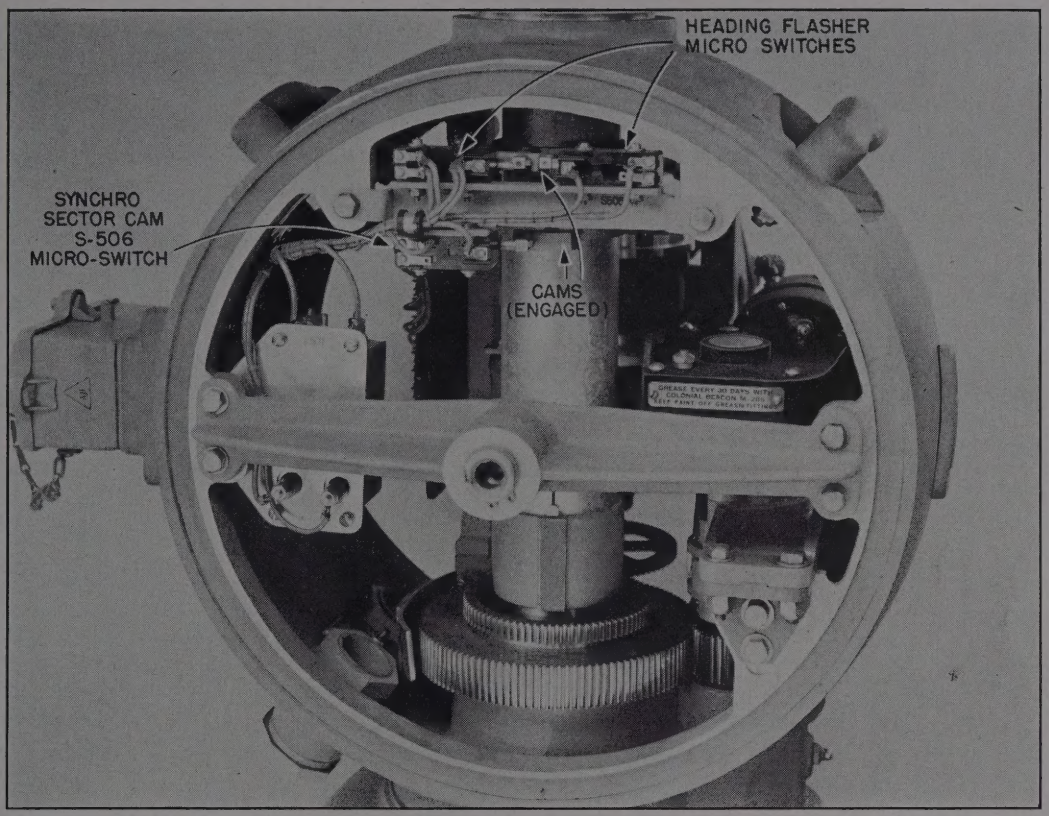


Figure 5-21—Antenna Pedestal: Synchro Cams and Micro-Switches

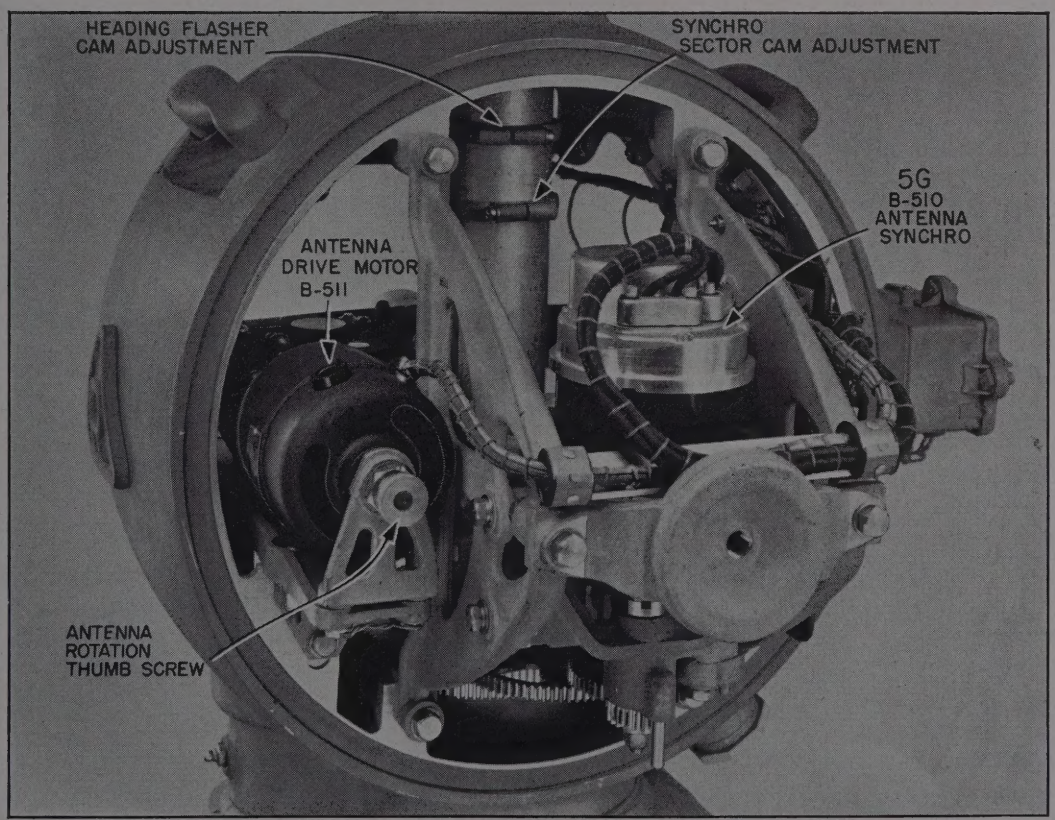


Figure 5-22—Antenna Pedestal: Drive Motor and Synchro

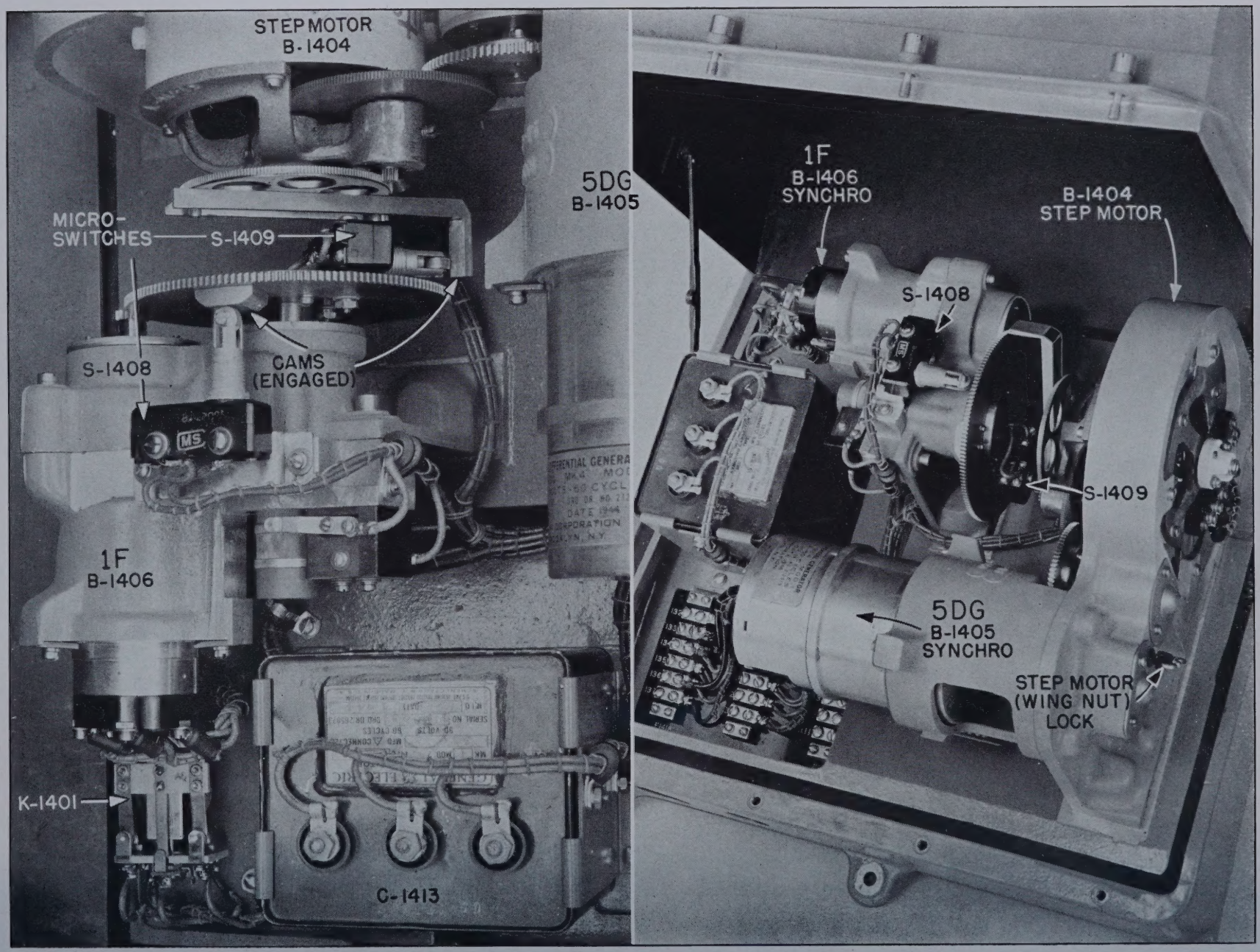


Figure 5-23—Bearing Control Unit: Details

(7) ADDITIONAL ALIGNMENT INFORMATION. — The synchro system is aligned at the factory so that the foregoing alignment procedure will normally be sufficient. Should difficulty be encountered during the initial installation, or should cams, synchros, or gearing be disturbed during repair, the following extensive alignment will be required:

(*a*) Follow steps (*a*) through (*g*) under "Alignment of Synchro System."

(*b*) Remove the 1F synchro (B-1406) from its mounting in the Bearing Control Unit by removing the three clamping screws.

(*c*) Turn on the equipment.

(*d*) Loosen the 5DG synchro (B-1405) and rotate its body until the PPI sweep is on zero.

(*e*) Tighten the clamping screws on the 5DG synchro.

(*f*) Install the 1F synchro and maintain cam contact with micro-switch S-1408 while engaging the coupling.

(*g*) Tighten the clamping screws on the 1F synchro.

(*h*) Rotate the Antenna several times in both directions to make sure that the PPI sweep locks in and keeps in step with the Antenna.

(*i*) Follow all the steps under "Routine Alignment Check."

Note

If the Antenna and sweep still do not synchronize, look for trouble in all synchro micro-switches, or in relays K-401 and K-1401.

j. RESONANCE CHAMBER. — Remove the unit cover once a month and check for water leakage. Inspect the motor brushes for wear or sticking. Lubricate the motor and other moving parts sparingly, and only if required to obtain free movement. If the resonance indicator (Meter **13** on the A.C.U.) does not respond when TUNE Switch **5** is operated, check the Resonance Chamber for failure to rotate and for a poor crystal rectifier. Replace the crystal if necessary.

The drive motor has an adjustable mounting base which is used to set the cam position for proper tuning of the Resonance Chamber through the X-band. Should the tuning range approach either the high or low point of the cam, readjust the position of the motor with the cam in mid-range (the cam is marked at its center) until Meter **13** on the A.C.U. indicates resonance.

k. MISCELLANEOUS.

(1) REPLACEMENT OF TUBES. — All tubes are secured in their sockets by locking devices which keep them firmly in place under shock and vibration. These locks must be released before the tubes are removed from their sockets.

To remove a conventional-type glass tube, either depress the spring grips at its base or throw the small lever so as to loosen the tube clamp, then withdraw the tube.

To remove a receiver tube secured by an individual base clamp, throw the small lever on the clamp, then withdraw the tube vertically. To remove a receiver tube secured by a base plate, remove the plate by taking out the securing screws, then withdraw the tube. In any case, the cover must first be removed from the receiver chassis.

The removal of the local oscillator tube in the Receiver is described on page 5-9. The removal of other special tubes, such as the magnetron and PPI tube, is described under the unit to which they belong.

CAUTION

Special devices are used to secure the magnetron, local oscillator, and cathode-ray tubes, as well as the TR and ATR tubes. Because these tubes are fragile, no attempt should be made to replace them until the special instructions have been carefully read.

(2) DEHYDRATOR PLUGS. — The dehydrator plugs ("Protek-Plugs") used in the Transmitter-Receiver, Indicator, and Accessory Control Unit become exhausted after a time and must be replaced. The life of these plugs depends mainly on the tightness of the seals on the unit cases and the number of times that these seals are disturbed. Normally the plugs will dehydrate the units several times after initial installation and sealing. If, however, the seals leak, earlier replacement may be necessary. When new, all plugs are deep blue in color; as they absorb the moisture within the units, all plugs change to a light pink.

Whenever a sealed unit has been opened, the long dehydrator plugs should be examined before resealing the case. If both long plugs are still blue for half their length or more, they need not be replaced; but if either plug is blue for less than half its length, both should be replaced.

The unit cases should not be left open longer than necessary. *As soon as a case is opened, the per-*

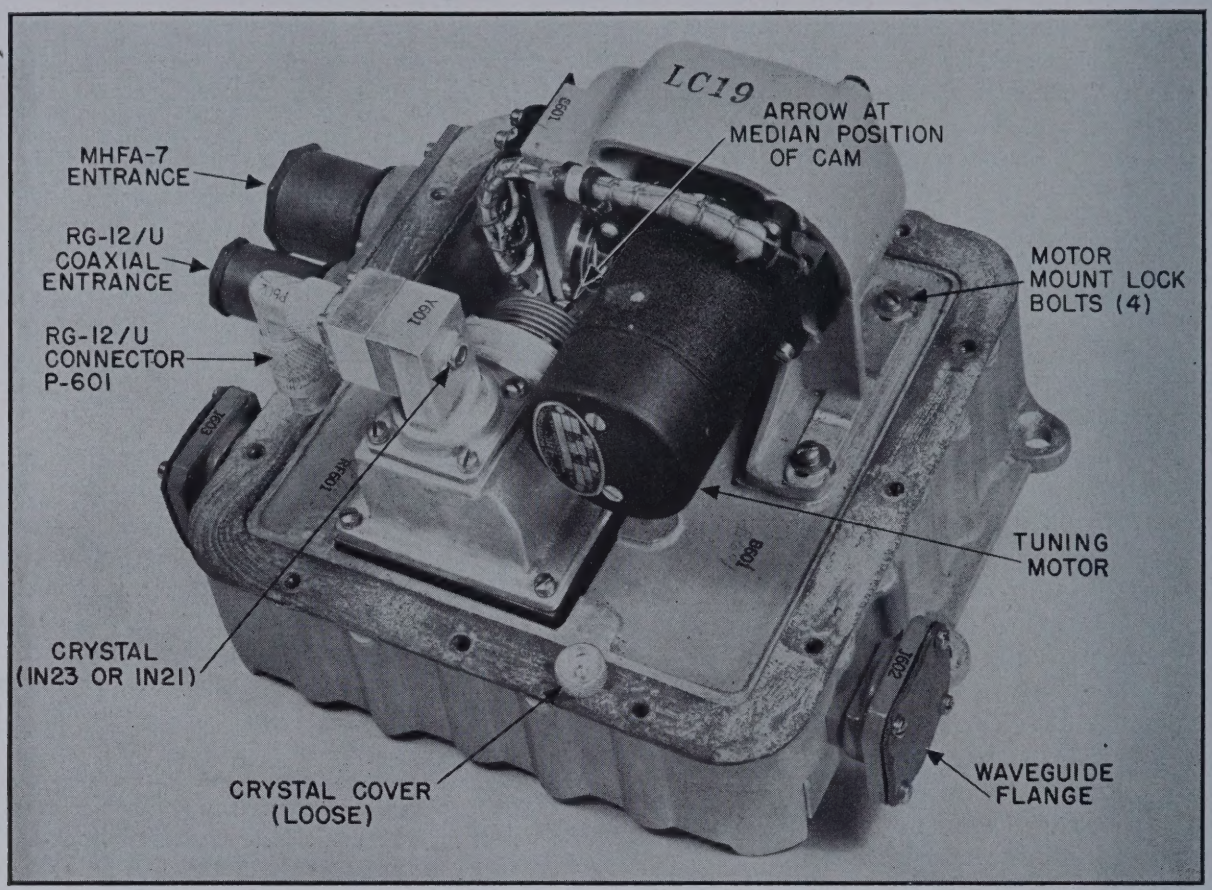


Figure 5-24—Resonance Chamber (Cover Removed)

forated ends of the dehydrator plugs should be sealed with Scotch tape or masking tape to prevent absorption of moisture from the open air.

Spare dehydrator plugs are supplied in small sealed tins and may be found in tender spares. A color chart is included in each tin which shows the appearance of the plugs in various stages of exhaustion.

Replacement of the dehydrator plugs is accomplished by unscrewing the exhausted plug from its mounting socket and screwing in a new plug. The red sealing wax disk should be removed from the new plug just before mounting it.

The dehydrator plugs may be successfully reclaimed by baking them at a moderate temperature (200° F.) for 1½ times as long as is required to restore the normal blue color.

(3) CABLES AND CONNECTORS.— Cables, terminals, jacks, and plugs should be frequently inspected and repaired, tightened or replaced from tender spares when necessary. Occasional cable failure is inevitable, especially in cables subjected to frequent bending. Coaxial cables are liable to short owing to flowing of the soft dielectric.

Jack and plug connectors employed on removable units should be frequently inspected and cleaned when necessary. These units should never be forced into place as bending of the contacts may result. When replacing the Indicator or A.C.U., the chassis release lever at the right rear of the unit must be properly operated.

Terminal connections should be so dressed that there is no likelihood of short circuits or chafing between the leads and moving parts or cases.

If individual leads open in any of the existing cables, the spares in the cables may be used until new cables can be installed. A continuity tester is useful in locating spares and in checking the color coding.

The pulse cable leading from the Modulator to the Transmitter employs a semisolid dielectric. This cable should be kept free of sharp bends to prevent "flowing" of the center conductor toward the shield. To prevent breakage from vibration, the lead should be installed at the Modulator with a moderately long loop and should be well supported by clamps and connectors. The minimum bending

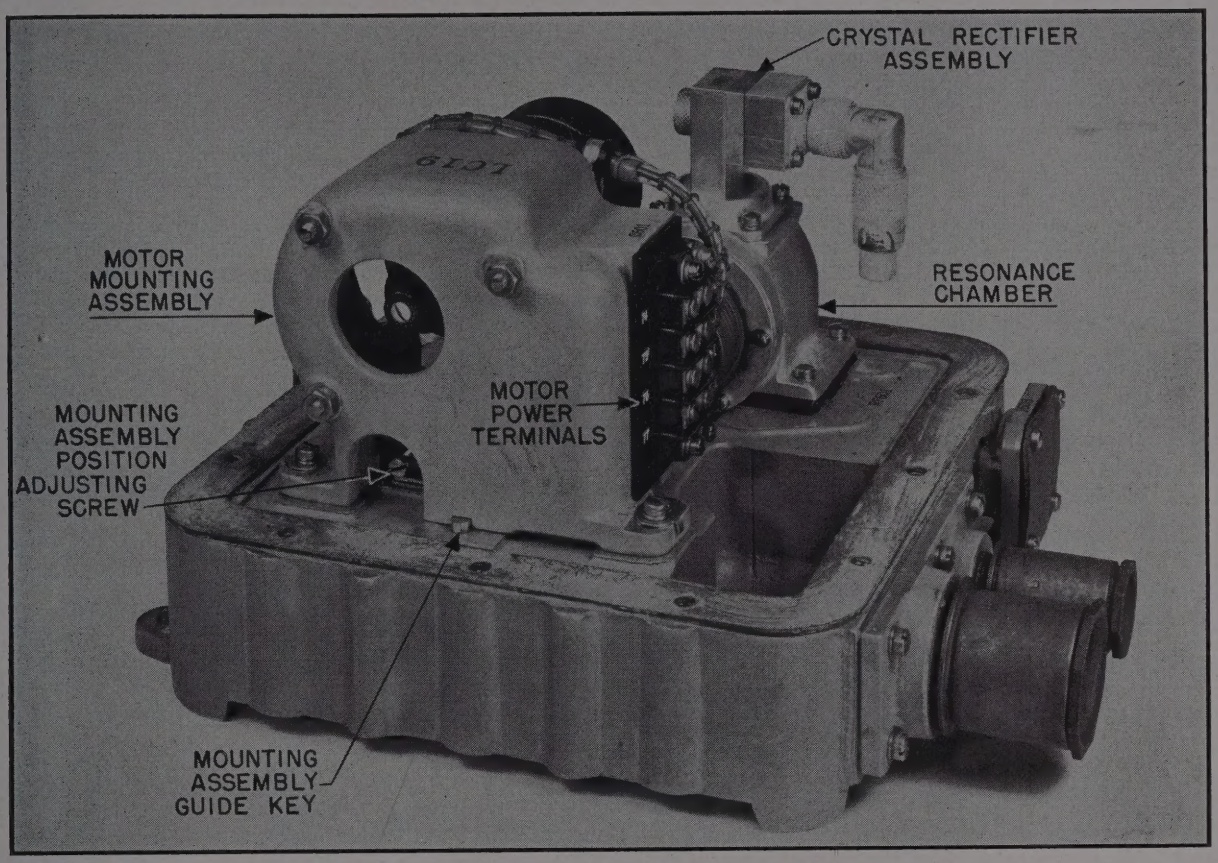


Figure 5-25—Resonance Chamber (Cover Removed)

radius is 8″. This also applies to the trigger and IFF trigger cables leading from the Modulator.

When it becomes necessary to replace coaxial cables, carefully dismantle the connectors and note or sketch the manner in which they were assembled. Prepare the new cable ends exactly like the old, carefully soldering the leads and using as little heat as proper soldering requires. This precaution may prevent damage to the dielectric. When installing or replacing the pulse cable, the dielectric should be handled as little as possible and should be scraped lightly or cleaned of dirt and flux after the soldered connectors have been made. (See the cable assembly procedures at the end of Sec. II.)

(4) ELECTRICAL CONTACTS. — All electrical rotating contacts (such as are found on the Motor-Alternator, magnetron blower motor, slewing motor, and PPI sweep coil) should be frequently checked for brush wear and for dirty, worn, or pitted surfaces. Brushes for all units will be found boxed and labeled in ship's spares. Slip rings and commutator segments should be cleaned with canvas pads or, if extremely worn or oxidized, with fine sandpaper or crocus cloth. *Do not use emery cloth on commutators or slip rings.* Brush tension should be even and the brushes should be free in their holders.

TABLE 5-2.—FUSE LOCATIONS

Model SO-4 Radar Equipment

Fuse and Value	*Location*	*Function*	*Test Point; Voltage to Ground or Between Terminals**
F-101, 10 amps.	Modulator fuse panel	Main supply line	Has fuse indicator
F-102, 2 amps.	Modulator fuse panel	Not used	Has fuse indicator
F-103, 2 amps.	Modulator fuse panel	Thyratron filament supply; repetition oscillator power	Has fuse indicator
F-104, 2 amps.	Modulator fuse panel	Main supply line relay	Has fuse indicator
F-105, 6 amps.	Modulator fuse panel	Synchro excitation	Has fuse indicator
F-106, 2 amps.	Modulator fuse panel	Primary of filament transformer in high-voltage rectifier	Has fuse indicator
F-107, 3.2 amps.	Modulator fuse panel	Antenna synchronizing relay (delay fuse)	Has fuse indicator
F-108, 3.2 amps.	Modulator fuse panel	Antenna motor power supply (delay fuse)	Has fuse indicator
F-109, 1 amp.	Modulator fuse panel	Antenna heater	Has fuse indicator
F-201, 1 amp.	Rectifier Power Unit: fuse panel	Blower motor; primary of keep-alive transformer; primary of receiver filament transformer	Has fuse indicator
F-202, 1 amp.	Rectifier Power Unit: fuse panel	Primary of transformer T-201 (relay supply)	Has fuse indicator
F-203, 2 amps.	Rectifier Power Unit: fuse panel	Primary of receiver power supply transformer	Has fuse indicator
F-205, 0.4 amp.	Rectifier Power Unit: fuse panel	24-volt d.c. blower motor supply (*not used*)	Has fuse indicator
F-206, 3 amps.	Rectifier Power Unit: fuse panel	Primary of magnetron filament transformer	
F-207, 2 amps.	Rectifier Power Unit: fuse panel	Primary of indicator power-supply transformer	
F-401, 1 amp.	Indicator: second fuse on left	Primary of power-supply transformer for PPI tube	Across fuse 0 volts
F-402		Not used	
F-403, 6 amps.	Indicator: third fuse on left	Synchro excitation	Terminals 42 and 43 on P-401 or on E-512 115 volts 60 cycles
F-404, 2 amps.	Indicator: fourth fuse on left	Primary of indicator filament transformer; primary of power-supply transformer for PPI tube	Across fuse 0 volts
F-701, 2 amps.	Accessory Control Unit: right side above chassis	Primary of A.C.U. power-supply transformer, and a.c. line voltmeter	Across fuse 0 volts
F-702, 3 amps.	Accessory Control Unit: center left above chassis	A.F.C. relay K-3101 and echo box tuning motor B-601	Terminal 77 on J-701 24 volts d.c.
F-2001, 10 amps.	Motor-Alternator Control Unit: fuse panel	Starting relay circuits	Across fuse 0 volts
F-2002, 10 amps.	Motor-Alternator Control Unit: fuse panel	Starting relay circuits	Across fuse 0 volts

Note

No fuses are contained in the following units: Antenna Assembly, Resonance Chamber, Transmitter-Receiver, and Junction Box.

*Fuse is probably good if corresponding test point voltage is roughly as shown; probably blown if not.

TABLE 5-3. — VOLTAGE MEASUREMENTS

MODEL SO-4 RADAR EQUIPMENT

RECTIFIER POWER UNIT CRP-20ACU

Measurements made from the designated terminals to ground, using a 20,000-ohms-per-volt meter with the Transmitter radiating and with the A.F.C.–MANUAL Switch set to "A.F.C." Terminals 7, 24, 27, 29, 31, and 50 are all grounded.

With normal 115-volt 60-cycle input, voltages may vary ±10% from values shown. All voltages d.c. unless otherwise noted.

Terminal Number	*Terminal Strip Number*	*Voltage*
1 & 2	E-201	115 a.c.
2 & 5	E-201	115 a.c.
36 & 1	E-201	115 a.c.
56 & 2	E-201	115 a.c.
47 & 50	E-202	320
48 & 50	E-202	300
49 & 50	E-202	290
50 & 51	E-202	–20
52 & 53	E-202	115 a.c.
7 & 9	E-203	27
10 & 7	E-203	27
13 & 12	E-203	115 a.c.
22 & 7	E-203	27
26 & 31	E-203	–250
28 & 31	E-203	–105
79 & 7	E-203	27
11 & 7	E-204	27
12 & 13	E-204	115 a.c.
27 & 8	E-204	27
29 & 11	E-204	27
8 & 27	E-204	27
14 & 29 (GAIN Control full cw.)	E-204	0
14 & 29 (GAIN Control full ccw.)	E-204	–100
15 & 29 (TUNE SET Control cw.; TUNE Control ccw.)	E-204	–42
15 & 29 (TUNE SET Control ccw.; TUNE Control cw.)	E-204	–245
21 & 31	E-205	27
34 & 35	E-205	115 a.c.
30 & 31	E-205	–250 reg.
20 & 31	E-205	27
18 & 2	E-205	115 a.c.
17 & 31 (GAIN Control full cw.)	E-205	0
17 & 31 (GAIN Control full ccw.)	E-205	–9
16 & 31	E-205	Same as 15 & 29
19 & 2	E-206	115 a.c.
23 & 12	E-206	115 a.c.
24 & 25	E-206	27
32 & 31 (GAIN Control full cw.)	E-206	117
32 & 31 (GAIN Control full ccw.)	E-206	140
33 & 31	E-206	300
35 & 2	E-206	115 a.c.
73 & 24	E-206	115 a.c.
69 & 7	E-206	27

TABLE 5-4. — VOLTAGE MEASUREMENTS

MODEL SO-4 RADAR EQUIPMENT

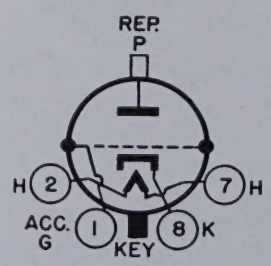
RADAR RECEIVER CRP-46ADA/'ADP

Measurements made from the designated terminals to ground using a 20,000-ohms-per-volt meter and with the Transmitter NOT *radiating.*

With normal 115-volt 60-cycle input, voltages may vary ±10% from values shown. All voltages measured with GAIN Control R-498 at minimum, except for V-3105 and V-3106, in which case the GAIN Control is set at maximum.

Tube	*Type*	*Pin 1*	*Pin 2*	*Pin 3*	*Pin 4*	*Pin 5*	*Pin 6*	*Pin 7*	*Pin 8*
V-3103	723A	300	0	90 cap*	—	—	—	6.3	0
V-3104	6AC7	0	0	0	0	1.8	139	6.3	139
V-3105	6AC7	0	0	0	0	1.5	115	6.3	115
V-3106	6AC7	0	0	0	0	1.65	120	6.3	120
V-3107	6AC7	0	0	0	0	1.75	140	6.3	140
V-3108	6AC7	0	0	0	0	1.85	140	6.3	140
V-3109	6AC7	0	0	0	0	1.9	145	6.3	275
V-3110	6H6	0	0	0	0	—	—	6.3	—
V-3111	6AC7	0	0	0	0	1.16	100	6.3	300
V-3112	6AC7	0	0	0	0	1.75	140	6.3	140
V-3113	6H6	0	0	0	0	0	—	6.3	0
V-3114	6AC7	0	0	0	0	1.52	72	6.3	160
V-3115	2050	—	6.3 to pin 7	—	—	—	—	6.3 to pin 2	—
V-3116	884	—	6.3 to pin 7	—	—	—	—	6.3 to pin 2	—

* *Average — varies with tuning.*



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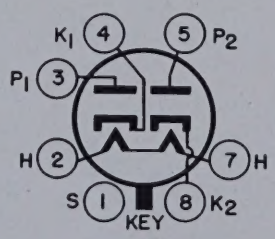

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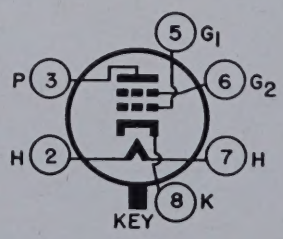

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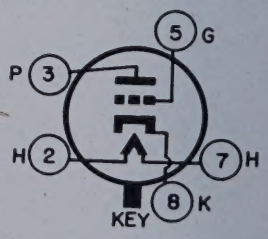

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TABLE 5-5.—VOLTAGE MEASUREMENTS

MODEL SO-4 RADAR EQUIPMENT

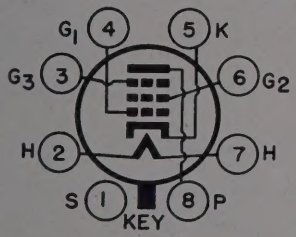
PLAN POSITION INDICATOR CRP-55AEM

Measurements made from the designated terminals to ground using a 200,000-ohms-per-volt meter and with the Transmitter NOT *radiating.*

With normal 115-volt 60-cycle input, voltages may vary ±10% from values shown. All voltages measured with Indicator not triggered, no signals applied, and controls set as follows:

M.V. Bias R-429 to clockwise limit. *Center R-421 to counterclockwise limit.*
Sweep Length R-423 to counterclockwise limit. *Intensity R-459 to counterclockwise limit.*
Range Switch S-401 to "4."

Tube	*Type*	*Pin 1*	*Pin 2*	*Pin 3*	*Pin 4*	*Pin 5*	*Pin 6*	*Pin 7*	*Pin 8*
V-401	6SN7-GT	0	120	0	120	300	175	6.3 a.c.	0
V-402	6SN7-GT	–18	– 19	–19	1.3	80	0.15	6.3 a.c.	0
V-403	807	6.3	150	–18	15	0	300 cap	——	—
V-404	6SN7-GT	–18	19	0	1.8	0	0	6.3 a.c.	0
V-405	6SN7-GT	0.35	85	0	–0.2	70	0	6.3 a.c.	0
V-406	6SN7-GT	0	70	0.25	–0.6	80	0.7	6.3 a.c.	0
V-407	5FP7	——	6.3 a.c. to pin 8	127	——	70	4500 cap	100	6.3 a.c. to pin 2



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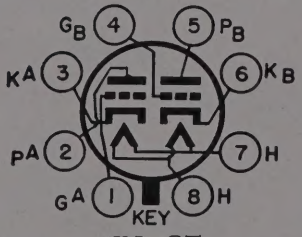

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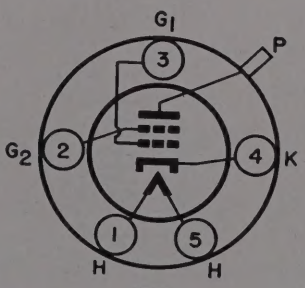

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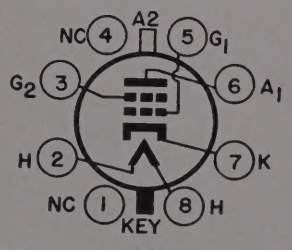

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TABLE 5-6. — VOLTAGE MEASURMENTS

MODEL SO-4 RADAR EQUIPMENT

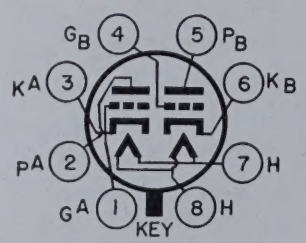
ACCESSORY CONTROL UNIT CRP-23AFD

Measurements made from the designated terminals to ground using a 20,000-ohms-per-volt meter and with the Transmitter NOT *radiating.*

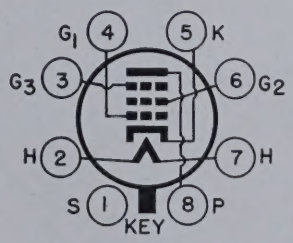
With normal 115-volt 60-cycle input, voltages may vary ±10% from values shown. All voltages measured with the A.C.U. not triggered, all Limit Set Controls at counterclockwise limit, Range Dial 14 at zero, and Range Switch J (on the Indicator) on 4 miles.

Tube	*Type*	*Pin 1*	*Pin 2*	*Pin 3*	*Pin 4*	*Pin 5*	*Pin 6*	*Pin 7*	*Pin 8*
V-701	6SN7-GT	50	70	50	70	210	75	6.3	0
V-702	6SN7GT	210	210	205	70	70	75*	6.4 to pin 8	6.4 to pin 7
V-703	6AC7	0	0	0	0	1.75	14	6.3	210
V-704	6SN7-GT	0	210	8.6	0	200	16	6.3	0
V-705	VR105-30	—	105	—	—	210	—	—	—
V-706	VR105-30	—	0	—	—	105	—	—	—
V-707	5U4-G	—	390 d.c.	—	360 a.c.	—	360 a.c.	—	390 d.c.

* *Varies with setting of Range Dial 14.*



6 SN 7-G T



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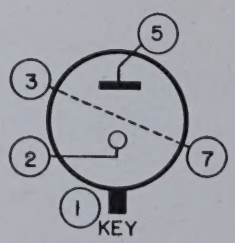

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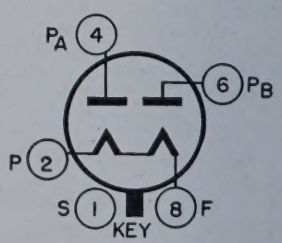

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TABLE 5-7.— TEST POINT LOCATIONS

MODEL SO-4 RADAR EQUIPMENT

All locations are described looking at the top side with units positioned as follows: Modulator, open side toward operator; Transmitter-Receiver, Receiver Unit toward operator; Plan Position Indicator, Accessory Control Unit, and Adaptor for PPI Repeater, panels toward operator. This system is maintained for underside locations.

Modulator Unit

"A"	Right rear, on J-101
"C"	Right rear, on J-102
J-103	Right rear
J-110	Right front on shelf (after Equipment #3)
R-101 — R-104	Upper right rear
R-140 — R-159	Upper left on shelf
R-160 — R-161	Upper left on shelf
R-172 — R-173	Front center on shelf
C-105	Front left on sub-chassis
T-101	Lower left rear
T-105	Left center on shelf
T-106	Left center on shelf
T-108	Right rear on shelf
Z-101	Rear center on shelf
L-102	Center on shelf
V-101	Lower right under shelf
V-102	Lower right under shelf
V-103	Lower right under shelf
V-105	Front left on sub-chassis
V-106	Front left on sub-chassis

Transmitter-Receiver Unit

"J"	In junction box beneath unit, on P-304
J-305	On cooling fins of pulse transformer
Terminals 30–32	Beneath unit, on J-304
T-301	Left rear
J-3101	Receiver Unit, left rear
J-3102	Receiver chassis, right center
J-3103	Receiver chassis, right front
R-3134	Beneath receiver chassis, front center
R-3137	Beneath receiver chassis, front center
R-3139	Beneath receiver chassis, right center
R-3141	Beneath receiver chassis, right side
R-3142	Beneath receiver chassis, right side
R-3143	Beneath receiver chassis, right side
K-3101	Receiver Unit, front center
V-3103	Receiver Unit, left rear
V-3104 — V-3109	Receiver Unit, rear
V-3110	Receiver Unit, left rear
V-3111	Receiver Unit, left front
V-3112	Receiver Unit, right end
V-3113	Receiver Unit, right front
V-3114 — V-3116	Receiver Unit, front center

Plan Position Indicator

P-401	Center rear
P-402	Rear of PPI assembly
E-401	Right center, top of PPI assembly
S-401	Range Switch, front panel, lower left
C-401	Left rear of sub-panel beneath chassis
C-417	Left rear of sub-panel beneath chassis
C-419	Left rear of sub-panel beneath chassis
R-412	Left center of sub-panel beneath chassis
R-423	Sweep Length Control, front panel, left center
R-424	Left front of sub-panel beneath chassis
R-429	Left front of chassis
R-439	Left rear of sub-panel beneath chassis
R-449	Left rear of sub-panel beneath chassis
R-455	MARKS Control, front panel, upper right
R-456	Left rear of sub-panel beneath chassis

TABLE 5-7.— TEST POINT LOCATIONS (Continued)

Plan Position Indicator (Continued)

R-459	Intensity Control, front panel, lower left
R-462	Left rear of sub-panel beneath chassis
R-463	Left rear of sub-panel beneath chassis
R-464	Left rear of sub-panel beneath chassis
R-468	FOCUS Control, front panel, lower right
R-486	Left rear of sub-panel beneath chassis
R-488	Left rear of sub-panel beneath chassis
R-493	Left rear of sub-panel beneath chassis
R-494	TUNE SET Control, front panel, right center
R-497	TUNE Control, front panel, right center
TC-401	Left center above chassis
TC-402	Left center above chassis
TC-403	Left center above chassis
V-401	Left center
V-402	Left center
V-403	Left rear
V-404	Left front
V-405	Left front
V-406	Left rear

Accessory Control Unit

"H"	In junction box at rear of unit, on P-701
C-701	Center of center sub-panel beneath chassis
C-704	Center of right sub-panel beneath chassis
C-706	Center of right sub-panel beneath chassis
C-710	Right center above chassis
C-715	Front of right sub-panel beneath chassis
R-703	Rear of right sub-panel beneath chassis
R-704	Rear of right sub-panel beneath chassis
R-705	Rear of right sub-panel beneath chassis
R-706	Rear of right sub-panel beneath chassis
R-707	Range potentiometer, front panel, lower center
R-709 — R-711	Rear of center sub-panel beneath chassis
R-713	8000 YD SET: HIGH Control, front panel, lower left
R-714	40,000 YD SET: HIGH Control, front panel, lower right
R-722	8000 YD SET: LOW Control, front panel, lower left
R-723	40,000 YD SET: LOW Control, front panel, lower right
R-725	Center of right sub-panel beneath chassis
R-727	Center of right sub-panel beneath chassis
R-734	MARK Control, front panel, lower right
R-736	Right rear of center sub-panel beneath chassis
R-737	Right center of center sub-panel beneath chassis
R-738	Right center of center sub-panel beneath chassis
K-701	Right side above chassis
T-704	Right center beneath chassis
T-705	Right center beneath chassis
E-701	Right rear beneath chassis
V-701	Right rear
V-702	Right rear
V-703	Right center
V-704	Right front

SECTION VI

PARTS LIST FOR NAVY MODEL SO-4 RADAR EQUIPMENT

TABLE I
LIST OF MAJOR UNITS
FOR MODEL SO-4 RADAR EQUIPMENT RX-1163

EQUIPMENT SPARES WX-5659
TENDER SPARES WX-5660
STOCK SPARES WX-5661

Navy Type Designation	Name of Major Unit	Table II		Assembly Drawing Number
		Symbol Group	Page Numbers	
CRP-50AEQ	Modulator	101 to 199	1 to 1-h	PA-9D-U3
CRP-20ACU	Rectifier Power Unit	201 to 299	2 to 2-f	A9F-L3
CRP-43ACN	Radar Transmitter-Receiver	301 to 399	3 to 3-k	PA9B-U12
CRP-46ADP	Radar Receiver	301 to 399		9B1-X3
CRP-55AEM	Plan Position Indicator	401 to 499	4 to 4-j	PA34C-U64
CRP-66AGS	Antenna Assembly	501 to 599	5 to 5-a	PA-9A-U17
CRP-14AAT	Resonance Chamber	601 to 699	6	A5E15-X67
CRP-62152	Junction Box	1300 to 1399	13 to 13-a	PA9E-U9
CDD-211241	Motor-Alternator	2101 to 2199	20 to 20-e	PA71A-U8
CDD-211242	Magnetic Controller	2001 to 2099	20 to 20-e	PA71A-U7
CDD-24921	Push Button Station			PU71A-U9
	Mounting & Interconnecting Material			
	Miscellaneous Tools, Parts, Wire, Hardware		26	
	Accessories			
CRP-23AFD	Accessory Control Unit	701 to 799	7 to 7-h	PA-9K-U4
CRP-10252	Mounting Rack			
CRP-53198	R.F. Filter Assembly	801 to 899	8	PA-9R-U7

11-4-44

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-50AEQ-1 MODULATOR

PART								SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		NAVY TYPE CRP-50AEQ-1 MODULATOR													
		Modulator	-50AEQ-1		28	RX-1110A		101		0		0		1	
		CAPACITORS													
C101	Filter capacitor	Capacitor, paper, 2 mfd., +30%,-10%, 5300 v dc wkg.			116	1346387	35-5296	115		1		2		3	C101
C102	Blocking grid capacitor	Capacitor, paper, .05 mfd., ±5%, 600 v dc wkg.			32	XTIMDW6-.05-5	35-5412	116		1		2		3	C102
C103	Filter capacitor	Capacitor, paper, 2 mfd., +15%-5%, 600 v dc wkg.			15	26F134	35-5312	117		1		2		3	C103
C104	By-pass capacitor	Capacitor, paper, 0.5 mfd., +20%-10%, 600 v dc wkg.			33	2529-3	35-5093	118		1		2		3	C104
C105	V105 screen coupling capacitor	Capacitor, paper, 0.1 mfd., ±10%, 600 v dc wkg.				A7150DA	35-5299	119		1		2		3	C105
		TERMINAL STRIPS AND MISCELLANEOUS ELECTRICAL PARTS													
E101	AC input connections	Terminal strip, barrier type, 6 terminals with 8-32 x 5/16" binder head screws			21	6-142	47-5018P5	140		0		0		1	E101
E102	Rectifier power unit connections	Terminal strip, barrier type, 12 terminals with 6-32 x ¼" binder head screws			21	12-141	47-5048P5	141		0		0		2	E102,E103
E103	Rectifier power unit connections	Same as E102								-		-		-	
E104	AC-DC connections	Terminal strip, barrier type, 4 terminals with 6-32 x ¼" binder head screws			21	4-141	47-5016P5	143		0		0		1	E104
E105	Switch chassis connections	Terminal strip, barrier type, 4 solder terminals with 6-32 x ¼" binder head screws			21	4-141-¼W	47-5016P3	144		0		0		1	E105
E106	Switch chassis connections	Terminal strip, barrier type, 5 solder terminals with 5-40 x 3/16 binder head screws			21	5-140-¼W	47-5042P3	145		0		0		1	E106
E107		Terminal strip, barrier type, 14 solder terminals with 6-32 x ¼" binder head screws			21	14-141-¼W	47-5051P3	149		0		0		1	E107
		Insulator, ceramic, 1" long, ½" dia., tapped 8-32, 3/8" deep at each end			40	1000	22-5015P2	150		1		2		4	
		Insulator, ceramic, 1" long, 1" sq. tapped 8-32, ¼" deep at each end			40	1060	22-5020	151		5		9		18	
		Insulator, ceramic, 2" long, ½" dia., tapped 8-32, ½" deep at each end			40	1003	22-5046P2	152		2		4		8	
		Insulator, ceramic, 2" long, ½" dia., tapped 6-32, ½" deep at each end			40	1003	22-5046P1	153		2		4		8	
		Insulator, ceramic 1¼" x 1" x 1"			40	#1061	22-5049P1	154		3		6		12	

0 No spares furnished
- For spares see reference given in "Description" column

Revised 11-21-44

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-50AEQ-1 MODULATOR

RESTRICTED

PART								SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		FUSES													
F101	Main line fuse	Fuse, 10 a, 250 v, length 2", ferrule dia. 9/16"		17-F-2	57	25010	26-5057	155		10		20		50	F101
F103	T104 & T107 fuse	Fusetron 2 a, 200 v, length 2" ferrule dia. 9/16"			46	402	26-5064	157		10		20		50	F103
F104	Fuse, K101 control circuit	Fuse, 2 a, 250 v, length 2" ferrule dia. 9/16"			57	25002	26-5036	158		20		40		100	F104,F106
F105	Fuse synchro power	Fuse 6 a, 250 v, length 2", ferrule dia. 9/16"		17-F-2	57	25006	26-5043	159		10		20		50	F105
F106	T102 fuse	Same as F104								-		-		-	
F109	Fuse antenna motor drive	Fuse 1 a, 250 v, length 2" dia., 9/16"			57	4032	26-5035	162		20		40		100	F109
		DIAL AND PILOT LIGHTS													
I101A	Fuse indicator	Neon bulb 1/25 w., 115 v, single contact miniature bayonet base			15	NE-15	77-5010P1	175		18		36		54	I101A, I102A, I103A, I104A, I105A, I106A, I107A, I108A, I109A
I101B	Receptacle for fuse indicator	Receptacle, pilot light assembly for miniature SC bayonet base lamp, clear lens			124	NE-915	81-5056P1	176		3		5		9	I101B, I102B, I103B, I104B, I105B, I106B, I107B, I108B, I109B
I102A	Fuse indicator	Same as I101A								-		-		-	
I102B	Receptacle for fuse indicator	Same as I101B								-		-		-	
I103A	Fuse indicator	Same as I101A								-		-		-	
I103B	Receptacle for fuse indicator	Same as I101B								-		-		-	
I104A	Fuse indicator	Same as I101A								-		-		-	
I104B	Receptacle for fuse indicator	Same as I101B								-		-		-	
I105A	Fuse indicator	Same as I101A								-		-		-	
I105B	Receptacle for fuse indicator	Same as I101B								-		-		-	
I106A	Fuse indicator	Same as I101A								-		-		-	
I106B	Receptacle for fuse indicator	Same as I101B								-		-		-	
I107A	Fuse indicator	Same as I101A								-		-		-	
I107B	Receptacle for fuse indicator	Same as I101B								-		-		-	
I108A	Fuse indicator	Same as I101A								-		-		-	
I108B	Receptacle for fuse indicator	Same as I101B								-		-		-	
I109A	Fuse indicator	Same as I101A								-		-		-	
I109B	Receptacle for fuse indicator	Same as I101B								-		-		-	
I110A	Warning lamp	Lamp, ¼ watt, 100 v., neon no resistance			15	NE-16	77-5005	193		2		4		6	I110A
I110B	Receptacle for warning lamp	Socket for neon lamp bayonet type			64	G414A	82-5013	194		1		1		1	I110B

- For spares see reference given in "Description" column

Revised 11-21-44

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-50AEQ-1 MODULATOR

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		RECEPTACLES													
J101	Trigger pulse connector	Receptacle, female, single conductor	-49194		2	83-1R	81-5043P1	200		1		2		4	J101, J102,
J102	Trigger pulse connector	Same as J101	-49194							-		-		-	
J110		Tip jack					76-5001G2	202		1		1		2	J110
		CONTACTORS AND RELAYS													
K101	Main line contactor	4 PST contactor with one normally open interlock circuit 115 v 60 ~ coil			98	N619	71-5037	204		0		0		2	K101
K101A		Set of (8) contact, stationary			98	23-1605	71-5039	205		8		16		24	K101A
K101B		Set of (4) contact, stationary			98	23-1606	71-5040	206		4		8		12	K101B
K101C		Set of (4) contact spring, movable			98	969-633	88-5091	207		4		8		12	K101C
K101D		Set of (2) return springs			98	969-547	88-5092	208		2		4		6	K101D
K101E		Interlock assembly normally open			98	10-664-9	28-5112	209		1		1		1	K101E
K101F		Set of (2) feeler gauges			98	41-290	11J-36	210		2		2		4	K101F
K101G		Shunt coil			98	9-1120	92-5106	211		1		2		3	K101G
		INDUCTORS AND CHOKES													
L102	DC resonance charging choke	Choke			28	UX-8887D	92-5172	215		1		0		2	L102
L103	Pulse line choke	Coil assembly					92-5257G1	216		1		0		2	L103
		PLUGS AND PROBES													
P101		Connector plugs					79-5046	220		1		2		4	P101, P102
P102		Same as P101								-		-		-	
		RESISTORS													
R101	Damping resistor	Resistor, wirewound, 125 Ω, Style C, Grade 1, Class 1	-63839-F		33		80-6040	235		2		6		10	R101, R102, R103, R104
R102	Damping resistor	Same as R101	-63839-F							-		-		-	
R103	Damping resistor	Same as R101	-63839-F							-		-		-	
R104	Damping resistor	Same as R101	-63839-F							-		-		-	
R105	Divider resistor	Resistor, composition, 180,000 Ω ±10%, ½ watt, pigtail terminals	-63360	RE 13A 340C	34	MB-½	80-5436	239		5		15		25	R105, R162, R163, R164, R165, R166, R167, R168, R169, R170
R106	C101 bleeder	Resistor, composition, 1 MΩ ±10%, 1 watt, pigtail terminals	-63288	RE 13A 340C	34	CM-1	80-5338	240		18		53		88	R106, R107, R108, R109, R110, R111, R112, R113, R114, R115, R116, R117, R118, R119, R120, R140, R141, R142, R143, R144, R145, R146, R147, R148, R149, R150, R151, R152, R153, R154, R155, R156, R157, R158, R159

0 No spares furnished
- For spares see reference given in "Description" column

Revised 11-21-44

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-50AEQ-1 MODULATOR

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		RESISTORS (Cont'd)													
R107	C101 bleeder	Same as R106	-63288							-		-		-	
R108	C101 bleeder	Same as R106	-63288							-		-		-	
R109	C101 bleeder	Same as R106	-63288							-		-		-	
R110	C101 bleeder	Same as R106	-63288							-		-		-	
R111	C101 bleeder	Same as R106	-63288							-		-		-	
R112	C101 bleeder	Same as R106	-63288							-		-		-	
R113	C101 bleeder	Same as R106	-63288							-		-		-	
R114	C101 bleeder	Same as R106	-63288							-		-		-	
R115	C101 bleeder	Same as R106	-63288							-		-		-	
R116	C101 bleeder	Same as R106	-63288							-		-		-	
R117	C101 bleeder	Same as R106	-63288							-		-		-	
R118	C101 bleeder	Same as R106	-63288							-		-		-	
R119	C101 bleeder	Same as R106	-63288							-		-		-	
R120	C101 bleeder	Same as R106	-63288							-		-		-	
R136	1110 limiting resistor	Resistor, composition, 30,000 Ω ±10%, 1 watt, pigtail terminals	-63288	RE 13A 340C	34	CM-1	80-5228	260		1		2		3	R136
R137	Limiting resistor for V106	Resistor, composition, 22,000 Ω ±10%, 1 watt, pigtail terminals	-63288	RE 13A 340C	34	CM-1	80-5454	261		1		2		3	R137
R138	Divider resistor	Resistor, composition, 390,000 Ω ±10%, ½ watt, pigtail terminals	-63360	RE 13A 340C	34	MB-½	80-5774	262		1		2		3	R138
R139	V105 cathode resistor	Resistor, composition, 5600 Ω ±10%, 1 watt, pigtail terminals	-63288	RE 13A 340C	34	CM-1	80-5726	263		1		2		3	R139
R140	Charging voltage divider	Same as R106	-63288							-		-		-	
R141	Charging voltage divider	Same as R106	-63288							-		-		-	
R142	Charging voltage divider	Same as R106	-63288							-		-		-	
R143	Charging voltage divider	Same as R106	-63288							-		-		-	
R144	Charging voltage divider	Same as R106	-63288							-		-		-	
R145	Charging voltage divider	Same as R106	-63288							-		-		-	
R146	Charging voltage divider	Same as R106	-63288							-		-		-	
R147	Charging voltage divider	Same as R106	-63288							-		-		-	
R148	Charging voltage divider	Same as R106	-63288							-		-		-	
R149	Charging voltage divider	Same as R106	-63288							-		-		-	
R150	Charging voltage divider	Same as R106	-63288							-		-		-	
R151	Charging voltage divider	Same as R106	-63288							-		-		-	
R152	Charging voltage divider	Same as R106	-63288							-		-		-	

- For spares see reference given in "Description" column

Revised 11-21-44

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-50AEQ-1 MODULATOR

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		RESISTORS (Cont'd)													
R153	Charging voltage divider	Same as R106	-63288							-		-		-	
R154	Charging voltage divider	Same as R106	-63288							-		-		-	
R155	Charging voltage divider	Same as R106	-63288							-		-		-	
R156	Charging voltage divider	Same as R106	-63288							-		-		-	
R157	Charging voltage divider	Same as R106	-63288							-		-		-	
R158	Charging voltage divider	Same as R106	-63288							-		-		-	
R159	Charging voltage divider	Same as R106	-63288							-		-		-	
R160	Divider resistor	Resistor, composition, 180,000 Ω ±10%, 1 watt, pigtail terminals	-63288	RE 13A 340C	34	CM-1	80-5768	284		1		3		5	R160,R161
R161	Divider resistor	Same as R160	-63288							-		-		-	
R162	Fuse indicator current limiter resistors	Same as R105	-63360							-		-		-	
R163		Same as R105	-63360							-		-		-	
R164		Same as R105	-63360							-		-		-	
R165		Same as R105	-63360							-		-		-	
R166		Same as R105	-63360							-		-		-	
R167		Same as R105	-63360							-		-		-	
R168		Same as R105	-63360							-		-		-	
R169		Same as R105	-63360							-		-		-	
R170		Same as R105	-63360							-		-		-	
R171	V106 grid leak	Resistor, composition, 22,000 Ω ±5%, 1 watt, pigtail terminals	-63355	RE 13A 340C	34	CM-1	80-5739	295		1		2		3	R171
R172	Repetition rate control	Potentiometer, wirewound, 10,000 Ω ±10%, 3 watt, linear taper with screw driver slot		RE 13A 492C	8	P58-W	40-5023P4	296		1		3		5	R172
R173	Vernier for R172	Resistor, potentiometer, wirewound, 2000 Ω 5 watt, linear taper with special shaft		RE 13A 492C			40-5157P1	297		1		3		5	R173
		SWITCHES, INTERLOCKS & THERMOSTATS													
S103	Battle switch	Switch, DPST, 10 a., 120 v.			109	9S4718L	28-5110	315		1		1		1	S103

- For spares see reference given in "Description" column

Revised 11-21-44

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-50AEQ-1 MODULATOR

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		TRANSFORMERS													
T101	Plate transformer H.V. rectifier	Transformer, plate Pri. 115/60/1φ Wind. / No. Turns / Wire Size / DC Res. / Volts / Amps / Test V r.m.s. Pri. 216 #16E 0.77 115 2 1780 Sec. A 4940 34E 1550 5900 .0376 Sec. B 4940 34E 1550 Pri. rated 230 va (approx.) Elec. Shield Pri. tapped at 183 turns				UX-9223A	92-5239	320		1		2		3	T101
T102	Filament transformer H.V. rectifier	Transformer, Filament: Pri. 115/60/1φ Wind. / No. Turns / Wire Size / DC Res. / Volts / Amps / Test V r.m.s. Pri. 307 23E 3.10 115 0.48 1780 Sec. #1 14 12E .0175 5 6.80 11kv Sec. #2 14 16E .035 5 3.25 20kv Sec. #1 & #2 CT Pri. rated at .55 va.			28	UX-7469D	92-683G1	321		1		2		3	T102
T103	Plate Transformer-Thyratron trigger	Transformer, Plate: Pri. 115/60/1φ Wind. / No. Turns / Wire Size / DC Res. / Volts / Amps / Test V r.m.s. Pri. 1500 36E 185 115 .035 1780 Sec. 6574 40E 2700 485 .005 1780 Sec. #1 CT Pri. rated at 4.00			29	UX-9201B	92-5169	322		1		2		3	T103
T104	Filament transformer	Transformer, Filament: Pri. 115/60/0φ Wind. / No. Turns / Wire Size / DC Res. / Volts / Amps / Test V r.m.s. Pri. 596 #26BM 10.1 115 .37 1780 Sec. 36 #14 .051 6.3 6.1 1780 Pri. rated at 42.7 va.			28	UX-9225A	92-5176	323		1		2		3	T104
T105	Blocking oscillator transformer	Transformer, Pulse: Wind. / No. Turns / Wire Size / DC Res. / Volts / Test V r.m.s. A Pri. 60 34E 3.1 A 1000 B Sec. #1 60 34E 3.2 B 1000 C Sec. #2 60 34E 3.3 C 1000				UX-9204A	92-5170	324		1		4		6	T105,T106
T106	Interstage transformer	Same as T105								-		-		-	

- For spares see reference given in "Description" column

Revised 11-21-44

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-50AEQ-1 MODULATOR

PART								SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		TRANSFORMERS (Cont'd)													
T107	Filament transformer	Transformer, Filament: Pri. 115/60/1ϕ Wind. / No. Turns / Wire Size / DC Res. / Volts / Amps / Test V r.m.s. Pri. 865 31E 46.00 115 160 1780 Sec.#1 108 22E 0.810 12/.6 .6 1780 Sec.#2 54 2x26E 0.550 6.3 0.65 1780 Pri. rated at 18.5 va. Sec.#1 CT				UX-9200A	92-5171	326		1		2		3	T107
T108	Trigger pulse transformer	Pulse transformer, Pri. 3250 v., 0.91 Mu sec. pulse to +35 volts and 100 volts			28	WX-5782	92-5253	327		1		2		3	T108
		* VACUUM AND GASEOUS DISCHARGE TUBES													
V101	H.V. rectifier	Half wave rectifier			28	3B24	90-5100			6		9		0	V101,V102,V103
V102	H.V. rectifier	Same as V101								-		-		-	
V103	Blocking tube	Same as V101								-		-		-	
V104	Switching tube	Hydrogen thyratron			19	4C35	90-5109			3		6		0	V104
V105	Trigger pulse amplifier	Video power amplifier, pentode	-6AG-7			6AG-7	90-5104			2		3		0	V105
V106	Blocking oscillator	Twin triode low mu amplifier	-6SN7-GT			6SN7-GT	90-5051			2		3		0	V106
V107	Rectifier trigger power supply	Full wave rectifier	-6X5-GT			6X5-GT	90-5057			2		3		0	V107
V108	Ballast tube for V106	Ballast tube 6.3 v., @ 0.6 a., octal base T-9 bulb			84	6-4	90-5088			3		6		0	V108
		SOCKETS AND FUSE HOLDERS													
X101	Socket for V101	Vacuum tube socket, 4 contacts ceramic wafer, silvered contacts	-49362	RE 49A 314B	110	224	82-5002	340		2		2		3	X101,X102,X103
X102	Socket for V102	Same as X101	-49362							-		-		-	
X103	Socket for V103	Same as X101	-49362							-		-		-	
X104	Socket for V104	Tube socket			15	M5556072G1	82-5022	343		1		1		1	X104
X105	Socket for V105	Octal socket, molded mica filled bakelite, 8 contacts			2	MIP8TM	82-5026	344		2		2		4	X105,X106,X107,X108
X106	Socket for V106	Same as X105								-		-		-	
X107	Socket for V107	Same as X105								-		-		-	
X108	Socket for V108	Same as X105								-		-		-	
		ASSEMBLIES													
Z101	Pulse forming line	Network-pulse forming line type 15-E4-.91-400-50P			33		92-5245P1	365		1		2		3*	Z101

0 No spares furnished
- For spares see reference given in "Description" column
* Packed in wooden boxes - see packing list

Revised 11-21-44

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-50AEQ-1 MODULATOR

PART								SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		MECHANICAL SPARES													
	H.V. bushing	Lead thru insulator assembly glass			28		37A8-27G1	375		1		1		2	
		Grommet, neoprene			87	978M	4-5049	376		1		2		4	
		Tube, clamp			119	1331	88-5146	378		1		1		1	
		Tube, clamp			28		88-5078P7	379		1		1		2	
		Fuse clip, 30 a. 250 v.	-28002		58		26-5008P1	380		4		9		36	
		Fuse clip, 60 a. 250 v	-28003		58		26-5009P3	381		1		2		8	
		Tube cap with lead and lug					27-5024G3	382		0		1		1	
		Tube cap with lead and lug					27-5024G4	383		0		1		1	
		Gasket			28		34D3-14P1	384		0		2		4	
		Gasket			28		34D3-14P2	385		0		2		4	
		Cork washer			28		37A1-53	386		2		4		8	
		Cork washer			28		87-19P1	387		20		40		80	
		Window			135		22M-75P1	388		1		2		3	
		Captive screw			135		9-5118P9	389		0		2		4	
		Tube clamp for small wafer octal tube base					88-5122	390		1		1		1	
		Tube clamp for intermediate shell octal tube base				926B-16	88-5078P5	391		1		1		2	
		Shockmount				100MPD3	39-5056	392		2		8		16	
		Captive screw					9-5214P2	393		0		1		2	
		Captive bolt					9-5215P2	394		0		1		2	
		Knob					3K1-191P1	395		1		2		3	
		Retaining ring					87-5047P1	396		2		4		6	

0 No spares furnished

Revised 11-21-44

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-20ACU RECTIFIER POWER UNIT

PART								SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		NAVY TYPE CRP-20ACU RECTIFIER POWER UNIT													
		Rectifier Power Unit	-20ACU		28	RX-1058		401		0		0		1	
		CAPACITORS													
C201	Filter capacitor	Capacitor, paper, 4 mfd., ±10%, 1000 v dc wkg.	-481050-10		9	TJU-10040	35-5063	406		2		5		8	C201, C202, C206
C202	Filter capacitor	Same as C201	-481050-10							-		-		-	
C203	Filter capacitor	Capacitor, paper, 6 mfd., ±10%, 600 v dc wkg.			9	TJU-6060	35-5141	408		3		8		13	C203, C204, C207, C208, C209
C204	Filter capacitor	Same as C203								-		-		-	
C205	By-pass capacitor	Capacitor, paper, 1 mfd., ±10%, 400 v dc wkg.	-481190		15	23F115	35-5152	410		2		5		8	C205, C210, C211
C206	Filter capacitor	Same as C201	-481050-10							-		-		-	
C207	Filter capacitor	Same as C203								-		-		-	
C208	Filter capacitor	Same as C203								-		-		-	
C209	Filter capacitor	Same as C203								-		-		-	
C210	By-pass capacitor	Same as C205	-481190							-		-		-	
C211	By-pass capacitor	Same as C205	-481190							-		-		-	
		TERMINAL STRIPS AND MISCELLANEOUS ELECTRICAL PARTS													
E201	Motor-Alternator input	Terminal strip, bakelite barrier type, 8 terminals with 6-32 x ¼" binder head screws			21	8-141	47-5021P1	419		0		0		5	E201, E202, E203, E204, E205
E202	Indicator connections	Same as E201								-		-		-	
E203	Indicator connections	Same as E201								-		-		-	
E204	Indicator connections	Same as E201								-		-		-	
E205	Trans.-Receiver connections	Same as E201								-		-		-	
E206	Transmitter-Receiver connections	Terminal strip, bakelite barrier type, 9 terminals with 6-32 x ¼" binder head screws			21	9-141	47-5023P1	424		0		0		1	E206
E207	K202 connections	Terminal strip, bakelite barrier type, 4 solder terminals with 5-40 x 3/16" binder head screws			21	4-140-¼W	47-5053P3	425		0		0		1	E207
		Insulator, ceramic, 1" long, ¼" dia., tapped 6-32, 3/8" deep at each end			40	1000	22-5015P1	426		1		1		2	
		Insulator, ceramic ½" long ¼" dia., tapped 8-32, 3/16" deep at each end			40	1400	22-5047	427		1		2		4	
		FUSES													
F201	Fuse for Transmitter-Receiver	Fuse, 1 a, 250 v, length 2", ferrule dia. 9/16"		17-F-2	57	25001	26-5035	428		40		80		200	F201, F202
F202	Fusetron for T201	Fuse delay (fusetron) 0.4 amps 250 v., length 2", ferrule dia., 9/16"			57	#4004	26-5058	429		20		40		100	F202, F205

11-4-44

0 No spares furnished
- For spares see reference given in "Description" column

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-20ACU RECTIFIER POWER UNIT

PART								SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		FUSES (Cont'd)													
F203	Fuse for T202	Fuse 2 amp 250 v length 2", ferrule dia. 9/16"		17-F-2	57	25002	26-5036	430		20		40		100	F203, F207
F205	Blower motor fuse	Same as F202								-		-		-	
F206	Fuse for modulator	Fuse, 3 a, 250 v, length 2", ferrule dia. 9/16"		17-F-2	57	25003	26-5037	433		10		20		50	F206
F207	Fuse for T203	Same as F203								-		-		-	
		DIAL AND PILOT LIGHTS													
I201A	Fuse pilot light	Neon bulb, 1/25 watt, T2 bulb, single contact, miniature bayonet base			15	NE-15	77-5010	440		12		24		36	I201A, I202A, I203A, I205A, I206A, I207A
I201B	Socket for I201A	Receptacle, pilot light, clear lens			28	NE-915	81-5056P1	441		2		3		6	I201B, I202B, I203B, I205B, I206B, I207B
I202A	Fuse pilot light	Same as I201A								-		-		-	
I202B	Socket for I202A	Same as I201B								-		-		-	
I203A	Fuse pilot light	Same as I201A								-		-		-	
I203B	Socket for I203A	Same as I201B								-		-		-	
I204A	Warning light	Neon bulb, ¼ watt			15	NE-16	77-5005	446		2		4		6	I204A
I204B	Socket for I204A	Socket for ¼ w neon bulb, bayonet type base			111	G414-A	82-5013	447		1		1		1	I204B
I205A	Fuse pilot light	Same as I201A								-		-		-	
I205B	Socket for I205A	Same as I201B								-		-		-	
I206A	Fuse pilot light	Same as I201A								-		-		-	
I206B	Socket for I206A	Same as I201B								-		-		-	
I207A	Fuse pilot light	Same as I201A								-		-		-	
I207B	Socket for I207A	Same as I201B								-		-		-	
		CONTACTORS AND RELAYS													
K201	Relay	Relay, 3 PDT 24 v dc coil			157	Type 27	71-5050	460		1		2		3	K201
K202	Time delay relay	Relay, SPST, 3 minute time delay 115 v 60~			159	C3M	71-5087	461		1		2		3	K202

- For spares see reference given in "Description" column

11-4-44

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-20ACU RECTIFIER POWER UNIT

PART								SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		INDUCTORS AND CHOKES													
L201	Auxiliary rectifier filter	Choke, .03 hy. ind. @ 2 amps. dc and 6 v. ac. test 1780 r.m.s., 160 turns #17E wire, 0.45 Ω dc res.			28	UX-9116	92-755G1	467		0		1		1	L201
L202 A B	Receiver supply filter, positive side	Dual choke assembly Section A-7 hy. min. ind. @ 75 ma dc, 3050 turns #32E wire, 220 Ω dc res. Section B-11 hy. min. ind. @ 60 ma dc, 4000 turns #33E wire, 350 Ω dc res.			28	WX-5141	92-801G1	468		1		1		1	L202
L203	Receiver supply filter, negative side	Choke, 25 hy. min. ind. @ 65 ma. dc and 6 v 120 ~ ac. Test 1780 r.m.s., 4200 turns #32E wire, 400 Ω max. dc res.			28	UX-9110	92-603G2	469		1		1		1	L203
L204	Indicator supply filter, positive side	Choke, 8.5 hy. ind. @ 125 ma dc and max. ac. Test 1780 v r.m.s. 2800 turns #30E wire, 140 Ω dc res.			28	UX-9119	92-466G3	470		1		1		1	L204
L205	Indicator supply filter, negative side	Choke, 25 hy. ind. @ 30 ma dc and max. ac. 6200 turns #35E wire, 740 Ω dc res.			28	UX-9118	92-725G2	471		1		1		1	L205
		RESISTORS													
R201	V205 screen dropping resistor	Resistor, composition, 750,000 Ω ±5%, 1 watt, pigtail terminals	-63291	RE 13A 340C	34	CM-1	80-5274	476		1		2		3	R201
R202	Voltage divider resistor	Resistor, composition, 220,000 Ω ±5%, ½ watt, pigtail terminals	-63355	RE 13A 340C	34	MB-½	80-5443	477		1		2		3	R202
R203	V205 plate load resistor	Resistor, composition, 750,000 Ω ±10%, ½ watt, pigtail terminals	-63360	RE 13A 340C	34	MB-½	80-5393	478		1		3		5	R203, R216
R204	Dropping resistor	Resistor, wirewound, 15,000 Ω ±5%, Style D, Grade 1, Class II		RE 13A 372J Style D	28		80-5550	479		1		3		5	R204
R205	Dropping resistor	Resistor, wirewound, 5000 Ω ±5%, Style D, Grade 1, Class II	-63085-E	RE 13A 372J Style D	28		80-5576	480		1		2		3	R205
R206	C204 bleeder resistor	Resistor, composition, 200,000 Ω ±10%, ½ watt, pigtail terminals	-63360	RE 13A 340C	34	MB-½	80-5391	481		1		2		3	R206
R208	Divider resistor	Resistor, composition, 40,000 Ω ±5%, 1 watt, pigtail terminals	-63291	RE 13A 340C	34	CM-1	80-5345	483		5		14		23	R208, R209, R210, R212, R213, R217, R218, R223, R224
R209	Divider resistor	Same as R208	-63291							-		-		-	
R210	Divider resistor	Same as R208	-63291							-		-		-	
R211	300 volt adjustment for receiver	Resistor, potentiometer, wirewound, 20,000 Ω ±10%, 3 watts, linear taper, special shaft		RE 13A 492C	8	P-58	40-5063	486		1		6		10	R211, R219
R212	Divider resistor	Same as R208	-63291							-		-		-	
R213	Divider resistor	Same as R208	-63291							-		-		-	
R214	Voltage divider resistor	Resistor, composition, 20,000 Ω ±5%, ½ watt, pigtail terminals	-63355	RE 13A 340C	34	MB-½	80-5375	489		1		2		3	R214
R215	Voltage divider resistor	Resistor, wirewound, 1000 Ω ±5%, Style D, Grade 1, Class II	-63076-E	RE 13A 372J Style D	33		80-5350	490		1		2		3	R215

0 No spares furnished
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(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-20ACU RECTIFIER POWER UNIT

PART								SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		RESISTORS (Cont'd)													
R216	Plate load resistor	Same as R203	-63360							-		-		-	
R217	Divider resistor	Same as R208	-63291							-		-		-	
R218	Divider resistor	Same as R208	-63291							-		-		-	
R219	300 volt adjustment for indicator	Same as R211								-		-		-	
R220	Indicator bias supply voltage divider resistor	Resistor, composition, 10,000 Ω ±5%, ½ watt, pigtail terminals	-63355	RE 13A 340C	34	MB-½	80-5219	495		1		2		3	R220
R221	Indicator bias voltage divider	Resistor, composition, 20,000 Ω ±5%, 1 watt, pigtail terminals	-63291	RE 13A 340C	34	CM-1	80-5272	496		1		2		3	R221
R222	Dropping resistor	Resistor, wirewound, 5500 Ω ±5%, Style E, Grade 1, Class II		RE 13A 372J Style E	28		80-5392	497		1		3		5	R222
R223	Divider	Same as R208	-63291							-		-		-	
R224	Divider	Same as R208	-63291							-		-		-	
R225	Dropping resistor	Resistor, wirewound, 2500 Ω ±5%, Style D, Grade 1, Class I	-63080-F	RE 13A 372J Style D	28		80-5886	500		1		2		3	R225
R226	V211 screen voltage divider resistor	Resistor, composition, 240,000 Ω ±5%, 1 watt, pigtail terminals	-63291	RE 13A 340C	34	CM-1	80-5464	501		1		2		3	R226
R228	Dropping resistor	Resistor, wirewound 500 Ω ±10%, Style E, Grade 1, Class II	-63278	RE 13A 372J Style E	28		80-5014	503		1		2		3	R228
R229	1204 current limiting resistor	Resistor, composition, 30,000 Ω ±10%, 1 watt, pigtail terminals	-63288	RE 13A 340C	34	CM-1	80-5228	504		1		2		3	R229
R230	V211 screen voltage divider resistor	Resistor, composition, 130,000 Ω ±5%, ½ watt, pigtail terminals	-63355	RE 13A 340C	34	MB -½	80-5526	505		1		2		3	R230
R233	Dropping resistor	Resistor, composition, 5000 Ω ±10%, 1 watt, pigtail terminals	-63288	RE 13A 340C	34	CM-1	80-5216	508		2		5		8	R233, R234, R235
R234	Dropping resistor	Same as R233	-63288							-		-		-	
R235	Dropping resistor	Same as R233	-63288							-		-		-	
R236	Bleeder resistor	Resistor, composition, 250,000 Ω ±10%, 1 watt, pigtail terminals	-63288	RE 13A 340C	34	CM-1	80-5237	511		1		2		3	R236
R237	Magnetron filament voltage dropping resistor	Resistor, wirewound, 1000 Ω ±5%, Style E, Grade 1, Class II	-63011-E	RE 13A 372J Style E	28		80-5017	512		1		2		3	R237
R238	Bleeder resistor	Resistor, composition, 470,000 Ω ±10%, 1 watt, pigtail terminals	-63288	RE 13A 340C	34	CM-1	80-5508	513		1		2		3	R238
R239	Current limiting resistor	Resistor, composition, 180,000 Ω ±10%, ½ watt, pigtail terminals	-63360	RE 13A 340C	34	MB-½	80-5436	514		3		9		15	R239, R240, R241, R242, R243, R244
R240	Current limiting resistor	Same as R239	-63360							-		-		-	
R241	Current limiting resistor	Same as R239	-63360							-		-		-	
R242	Current limiting resistor	Same as R239	-63360							-		-		-	

- For spares furnished see reference given in "Description" column

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-20ACU RECTIFIER POWER UNIT

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		RESISTORS (Cont'd)													
R243	Current limiting resistor	Same as R239	-63360							-		-		-	
R244	Current limiting resistor	Same as R239	-63360							-		-		-	
R245	K202 current limiting resistor	Resistor wirewound 800 Ω 6 w., Style F Grade 1, Class II	-631015				80-6050			1		2		3	R245
		SWITCHES, INTERLOCKS AND THERMOSTATS													
S202	Battle switch	Switch, DPST, 10 a, 120 v contacts silver plated			109	9-S-4718L	28-5110	525		1		1		1	S202
		TRANSFORMERS													
T201	Transformer, auxiliaryrectifier	Transformer, Selenium Rectfier: Pri. 115/60/1φ Wind. / No. Turns / Wire Size / DC Res. / Volts / Amps / Test V r.m.s. Pri. 625 21E 3.55 115 0.85 1780 Sec. 250 17E 0.800 42.5 2.00 1780 Sec. tapped at 200 and 225 turns Pri. rated: 95 va (approx.) Elec. shield			28	UX-9248	92-5212	530		1		2		3	T201
T202	Receiver power supply transformer	Transformer, Plate and Filament: Pri. 115/60/1φ Wind. / No. Turns / Wire Size / DC Res. / Volts / Amps / Test V r.m.s. Pri. 838 19E 1.50 115 1.40 1780 Sec. #1 2160 34E 550 1000 .045 2500 Sec. #2 2540 30E 210 795 .080 1780 Sec. #3 16 16E .053 5 3 1780 Sec. #4 16 16E .053 5 3 1780 Sec. #5 16 16E .040 5 3 1780 Sec. #6 20 20E .195 6.3 1.0 1780 Sec. #7 20 24E .50 6.3 0.3 1780 Sec. #1, #2, #6 and #7 CT. Sec. #2 tapped at 695 and 1845 turns Pri. rated: 162 va. (approx.) Elec. shield			28	UX-9125B	92-754G4	531		1		2		3	T202
T203	Indicator power supply transformer	Transformer, Plate and Filament: Pri. 115/60/1φ Wind. / No. Turns / Wire Size / DC Res. / Volts / Amps / Test V r.m.s. Pri. 345 19E 1.56 115 1.13 1780 Sec. #1 2660 30E 215 840 .110 2500 Sec. #2 1690 36E 550 530 .021 2000 Sec. #3 16 16E .063 5 3 1780 Sec. #4 16 16E .063 5 3 2500 Sec. #5 20 20E .21 6.3 1 1780 Sec. #6 20 26E .86 6.3 .3 1780 Sec. #1, #2, #5 and #6 CT. Pri. rated: 130 va. (approx.) Elec. shield			28	UX-9117A	92-754G1	532		1		2		3	T203

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(4)

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PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		*** VACUUM AND GASEOUS DISCHARGE TUBES**													
V201	Positive side rectifier	Full wave rectifier tube	-5U4-G		29	5U4-G	90-5056			10		15		0	V201, V202, V203, V209, V212
V202	Negative side rectifier	Same as V201	-5U4-G							-		-		-	
V203	Positive side rectifier	Same as V201	-5U5-G							-		-		-	
V204	Series regulator	Low Mu power triode	-6B4-G		29	6B4-G	90-5101			4		6		0	V204, V210
V205	Error voltage amplifier	Voltage amplifier pentode	-6SJ7-GT		29	6SJ7-GT	90-5102			4		6		0	V205, V211
V206	Voltage regulator	Gaseous regulator	OC3/VR-105		29	OC3/VR-105	90-5058			4		6		0	V206, V208
V207	Voltage regulator	Gaseous regulator	OD3/VR-150		29	OD3/VR-150	90-5061			2		3		0	V207
V208	Voltage regulator	Same as V206	OC3/VR-105							-		-		-	
V209	Positive side rectifier	Same as V201	-5U4-G							-		-		-	
V210	Series regulator	Same as V204	-6B4-G							-		-		-	
V211	Error voltage amplifier	Same as V205	-6SJ7-GT							-		-		-	
V212	Negative side rectifier	Same as V201	-5U4-G							-		-		-	
		SOCKETS AND FUSE HOLDERS													
X201	Socket for V201	Vacuum tube socket, 8 contacts, ceramic wafer, silvered contacts and mtg.			2	RSS-8M	82-5012P3	537		6		6		12	X201, X202, X203, X204, X205, X206, X207, X208, X209, X210 X211, X212
X202	Socket for V202	Same as X201								-		-		-	
X203	Socket for V203	Same as X201								-		-		-	
X204	Socket for V204	Same as X201								-		-		-	
X205	Socket for V205	Same as X201								-		-		-	
X206	Socket for V206	Same as X201								-		-		-	
X207	Socket for V207	Same as X201								-		-		-	
X208	Socket for V208	Same as X201								-		-		-	
X209	Socket for V209	Same as X201								-		-		-	
X210	Socket for V210	Same as X201								-		-		-	
X211	Socket for V211	Same as X201								-		-		-	
X212	Socket for V212	Same as X201								-		-		-	
		SELENIUM RECTIFIER													
SR201	Auxiliary power rectifier	Selenium rectifier			12	1SB4ARV1	32-5004	555		1		1		2	SR201

0 No spares furnished
- For spares see reference given in "Description" column
* Packed in wooden boxes - See packing lists

(4)

TABLE II
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FOR NAVY TYPE CRP-20ACU RECTIFIER POWER UNIT

PART								SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		MECHANICAL SPARES													
		Shock mount			91	#40	39-5024	570		2		6		12	
		Tube clamp for medium shell base			28	923-C	88-5078P1	571		2		2		4	
		Tube clamp for small shell base			28	926-A	88-5078P3	572		1		1		3	
		Tube clamp for small wafer base			28	929	88-5122	573		1		1		1	
		Internal retainer ring			28	Type B #37	87-5047P8	574		4		8		12	
		Shaft lock			28	10061	31-5013P2	575		1		1		2	
		Captive screw			28		9-5071P2	576		0		4		4	

2-f

0 No spares furnished

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-43ACN RADAR TRANSMITTER-RECEIVER
FOR USE WITH SO-4 RADAR EQUIPMENT

PART								SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		NAVY TYPE CRP-43ACN RADAR TRANSMITTER-RECEIVER													
		Radar Transmitter-Receiver	-43ACN		28	RK-1095		601		0		0		1	
		Radar Receiver	-46ADP		28	RK-1179				0		0		0	
		MOTORS AND SYNCHRO UNITS													
B301	Blower impeller driving motor	Motor for blower, 115 v, 60~, 3400 r.p.m., 1/40 hp.			133		115-5135	605		2		2		3	B301
B301D	Blower impeller	Impeller wheel, turbo type, for 5/16" dia. shaft.			28		115-5090P2	609		0		1		1	B301D
		CAPACITORS													
C301	Keep-alive filament cap.	Capacitor, paper, 0.1 mfd., ±10%, 1750 v dc wkg.	-48596-10		33	2526-2	35-5050	615		1		2		3	C301
C302	Filament by-pass capacitor	Capacitor, paper, .05 mfd., ±10%, 1000 v dc wkg.	CP2-G503KK	JAN-C-5	9	DYR-10005	35-5148	616		1		2		3	C302
C303	Metering circuit by-pass capacitor	Capacitor, mica, .025 mfd., ±10%, 1200 v dc wkg.	CM70-253KL	JAN-C-5	30	A2125	35-5102	617		1		1		1	C303
C304	Bias by-pass capacitor	Capacitor, paper, .25 mfd., ±10%, 1000 v dc wkg.			9	DYR-10005	35-5149	618		1		2		3	C304
C305	Blower motor capacitor	Capacitor, paper, 1.75 mfd., 330 v ac wkg.			15	26F-609	35-5191	619		1		2		3	C305
C306	Thermostat by-pass capacitor	Capacitor, paper, 0.5 mfd., ±10%, 400 v dc wkg.	-48205-A10	RE 48A 129E RE 13A 48BD	33	2528-2	35-5052	620		1		2		3	C306
C3101	Input by-pass capacitor	Capacitor, mica, .001 mfd., ±10%, 300 v dc wkg.	-481070C-10	RE 48A 154F	32	MCCW-1427-40	35-5086	626		6		18		29	C3101, C3102, C3103, C3105, C3106, C3107, C3108, C3110, C3111, C3113, C3114, C3116, C3117, C3119, C3120, C3126, C3127, C3128, C3129, C3130, C3131, C3141, C3142, C3143, C3144, C3145, C3146, C3147, C3151
C3102	V3104 cathode by-pass capacitor	Same as C3101	-481070C-10							-		-		-	

0 No spares furnished
- For spares see reference given in "Description" column

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-43ACN RADAR TRANSMITTER-RECEIVER
FOR USE WITH SO-4 RADAR EQUIPMENT

PART								SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
CAPACITORS (Cont'd)															
C3103	V3104 screen by-pass capacitor	Same as C3101	-481070C-10							-		-		-	
C3104	V3105 grid coupling capacitor	Capacitor, mica, .0001 mfd., ±10%, 500 v dc wkg.	-48674-10		32	MOW-1416-10	35-5021	629		2		5		7	C3104, C3108, C3112, C3115, C3118, C3122, C3130
C3105	V3105 grid by-pass capacitor	Same as C3101	-481070C-10							-		-		-	
C3106	V3105 cathode by-pass capacitor	Same as C3101	-481070C-10							-		-		-	
C3107	V3105 screen by-pass capacitor	Same as C3101	-481070C-10							-		-		-	
C3108	V3106 grid coupling capacitor	Same as C3104	-48674-10							-		-		-	
C3109	V3106 grid by-pass capacitor	Same as C3101	-481070C-10							-		-		-	
C3110	V3106 cathode by-pass capacitor	Same as C3101	-481070C-10							-		-		-	
C3111	V3106 screen by-pass capacitor	Same as C3101	-481070C-10							-		-		-	
C3112	V3107 grid coupling capacitor	Same as C3104	-48674-10							-		-		-	
C3113	V3107 cathode by-pass capacitor	Same as C3101	-481070C-10							-		-		-	
C3114	V3107 screen by-pass capacitor	Same as C3101	-481070C-10							-		-		-	
C3115	V3108 grid coupling capacitor	Same as C3104	-48674-10							-		-		-	
C3116	V3108 cathode by-pass capacitor	Same as C3101	-481070C-10							-		-		-	
C3117	V3108 screen by-pass capacitor	Same as C3101	-481070C-10							-		-		-	
C3118	V3109 grid coupling capacitor	Same as C3104	-48674-10							-		-		-	
C3119	V3109 cathode by-pass capacitor	Same as C3101	-481070C-10							-		-		-	
C3120	V3109 screen by-pass capacitor	Same as C3101	-481070C-10							-		-		-	
C3121	Reflector plate filter	Capacitor, mica, .001 mfd., ±10%, 500 v dc wkg.	-48983-10	RE 48A 143F RE 48A 154F	32	C-1210-10	35-5036	635		1		2		3	C3121, C3139, C3140
C3122	V3110 coupling capacitor	Same as C3104	-48674-10							-		-		-	
C3123	V3110 output by-pass capacitor	Capacitor, mica, .00001 mfd., ±10%, 500 v dc wkg.	-48770-10		32	MOW-1403-10	35-5131	637		1		1		1	C3123
C3124	V308 coupling capacitor	Capacitor, mica, .01 mfd., ±10%, 300 v dc wkg.	-48848-C10	RE 48A 143F RE 48A 154F	32	MWOW-1249-10	35-5096	638		1		1		1	C3124
C3125A B C	Video by-pass capacitor Video by-pass capacitor Video by-pass capacitor	Capacitor, paper, 3 x .1 mfd., ±20%, 600 v dc wkg.	-48709-A20	RE 48A 138C RE 48A 488D	33	2529-4	35-5092	639		1		2		3	C3125
C3126	V3104 plate by-pass capacitor	Same as C3101	-481070C-10							-		-		-	
C3127	V3105 plate by-pass capacitor	Same as C3101	-481070C-10							-		-		-	
C3128	Gain control filter capacitor	Same as C3101	-481070C-10							-		-		-	
C3129	Input by-pass capacitor	Same as C3101	-481070C-10							-		-		-	
C3130	V3112 cathode by-pass capacitor	Same as C3101	-481070C-10							-		-		-	
C3131	V3112 screen by-pass capacitor	Same as C3101	-481070C-10							-		-		-	

- For spares see reference given in "Description" column

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-43ACN RADAR TRANSMITTER-RECEIVER
FOR USE WITH SO-4 RADAR EQUIPMENT

PART								SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
CAPACITORS (Cont'd)															
C3132	V3113 output by-pass capacitor	Capacitor, mica, .00005 mfd., ±10%, 500 v dc wkg.	-48895-10		32	MOW-1410	35-5133	644		1		1		1	C3132
C3133	V3113 output by-pass capacitor	Capacitor, mica, .00002 mfd., ±10%, 500 v dc wkg.	-48783-10		32	MOW-1405	35-5132	645		1		1		1	C3133
C3134	V3114 screen by-pass capacitor	Capacitor, paper, .01 mfd., +20%-10%, 600 v dc wkg.	CP2-F103MK	RE 13A 488D	33	PX24A	35-5089	646		2		5		8	C3134, C3136, C3137
C3135	V3115 grid coupling capacitor	Capacitor, paper, .004 mfd., +20%-10%, 1000 v dc wkg.			33	PX24A	35-5159	647		1		2		3	C3135
C3136	V3115 plate capacitor	Same as C3134								-		-		-	
C3137	V3116 grid by-pass capacitor	Same as C3134								-		-		-	
C3138	Output coupling capacitor	Capacitor, paper, 1.0 mfd., ±10%, 600 v dc wkg.			32	XFMROWG-1	35-5406	650		1		2		3	C3138
C3139	V3103 repeller filter capacitor	Same as C3121	-48983-10							-		-		-	
C3140	V3103 grid filter capacitor	Same as C3121	-48983-10							-		-		-	
C3141	V3104 heater by-pass capacitor	Same as C3101	-481070C-10							-		-		-	
C3142	V3105 heater by-pass capacitor	Same as C3101	-481070C-10							-		-		-	
C3143	V3106 heater by-pass capacitor	Same as C3101	-481070C-10							-		-		-	
C3144	V3107 heater by-pass capacitor	Same as C3101	-481070C-10							-		-		-	
C3145	V3108 heater by-pass capacitor	Same as C3101	-481070C-10							-		-		-	
C3146	V3109 heater by-pass capacitor	Same as C3101	-481070C-10							-		-		-	
C3147	V3112 heater by-pass capacitor	Same as C3101	-481070C-10							-		-		-	
C3148	Input loading capacitor	Capacitor, mica, .000020 mfd., ±5% 500 v dc wkg.			32	MOOW	35-5315	656		1		1		2	C3148, C3149
C3149	Input loading capacitor	Same as C3148								-		-		-	
C3150	V3112 plate coupling capacitor	Same as C3104	-48674-10							-		-		-	
C3151	J3102 by-pass capacitor	Same as C3101	-481070C-10							-		-		-	
C3152	V3110 heater by-pass capacitor	Capacitor, paper, 0.5 mfd., +20%-10%, 600 v dc wkg.	-48704-A	RE 48A 138C RE 13A 488D	33	2529-3	35-5093	659		1		2		3	C3152
TERMINAL STRIPS AND MISCELLANEOUS ELECTRICAL PARTS															
E301	Magnet for V301	Magnet, permanent, 1.36" gap.			7		120-5007	660		0		1		2	E301
E302	Terminal strip for blower motor, thermostat & keep-alive assembly	Terminal strip, bakelite barrier type, 9 solder terminals with 5-40 x 3/16" binder head screws.			21	9-140-MW	47-5065P3	661		0		0		1	E302
E304	Terminal assembly for V302	Terminal assembly.			28		27-5024P2	663		0		1		2	E304
E305	Terminal assembly for V3101	Terminal assembly.			28		27-5155	664		0		1		2	E305

0 No spares furnished
- For spares see reference given in "Description" column

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-43ACN RADAR TRANSMITTER-RECEIVER
FOR USE WITH SO-4 RADAR EQUIPMENT

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		TERMINAL STRIPS AND MISCELLANEOUS ELECTRICAL PARTS (Cont'd)													
E306	Terminal strip for pulse transformer	Terminal strip, bakelite barrier type, 5 solder terminals with 6-32 x ¼" binder head screws.			21	5-141-¼W	47-5045P3	665		0		0		1	E306
E307	Protective gap for C303	Spark Gap			15	95X446	91-5155	666		1		2		3	E307
E308	Battle-phone terminal strip	Terminal strip, bakelite barrier type, 2 solder terminals with 5-40 x 3/16" binder head screws.			21	2-140-¼W	47-5047P3	667		0		0		1	E308
E3101	Receiver power terminal strip	Terminal strip, bakelite barrier type, 5 feed thru solder terminals with 5-40 x 3/16" binder head screws.			21	5-140-Y	47-5042P4	670		0		0		2	E3101, E3102
E3102	Receiver power terminal strip	Same as E3101								-		-		-	
	Insulator for J302	Insulator, special.			28	17P4-TypeCRG	22-5067P1	675		1		1		2	
	Insulator for bias box resistor panels	Insulator			40	#1400	22-5047	674		1		1		2	
		RECEPTACLES													
J302	Battle-phone jack	Jack, Navy T, for battle-phone.			105	9S5004L	76-5004	680		1		1		2	J302
J302A	Battle-phone jack mtg.	Gasket			28		5B16-85P1	681		1		2		4	J302A
J304	Cable connection to transmitter	Terminal jack panel.			28		5B3-443	683		1		1		2	J304
J304A	Jack assembly for J304	Receptacle, jack, banana type.			35	152347	51-5701G3	684		2		4		8	J304A
J3101	Receiver output jack	Chassis receptacle.	-49194		2	83-1R	81-5043	686		1		1		2	J3101
J3101A	Right angle adaptor	Plug adaptor, 90° angle.	-49192		2	83-1AP	79-5045	687		1		1		2	J3101A
J3102	Signal mixer metering jack	Closed circuit pin tip jack.			3		76-5006	688		1		1		2	J3102, J3103
J3103	AFC mixer metering jack	Same as J3102								-		-		-	
		CONTACTORS AND RELAYS													
K3101	AFC manual relay	Relay, DPDT, 24 v dc coil.			75	BJ-6D36	71-5031	693		1		2		3	K3101
K3102	Protective shutter actuating device	Relay			28		71-5065	694		1		2		3	K3102
		INDUCTORS AND CHOKES													
L3101	Input inductor	Inductor, RF, 7 turns #28E wire on 7/16" dia. ceramic form, slug tuned.			28		51-5880G3	697		0		1		2	L3101, L3110
L3102	Input transformer	Inductor, RF, two windings; 1st winding 15 turns #30E wire, 2nd winding 5 turns #28E wire. Both wound on single 7/16" dia. ceramic form, slug tuned.			28		51-5880G6	698		0		1		2	L3102, L3111

0 No spares furnished
- For spares see reference given in "Description" column

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-43ACN RADAR TRANSMITTER-RECEIVER
FOR USE WITH SO-4 RADAR EQUIPMENT

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		INDUCTORS AND CHOKES (Cont'd)													
L3103	V3105 interstage inductor	Inductor, RF, 12 turns #28E wire on 7/16" dia. ceramic form, slug tuned.					51-5880G4	699		0		3		5	L3103, L3104, L3105, L3106, L3107
L3104	V3106 interstage inductor	Same as L3103								-		-		-	
L3105	V3107 interstage inductor	Same as L3103								-		-		-	
L3106	V3108 interstage inductor	Same as L3103								-		-		-	
L3107	V3109 interstage inductor	Same as L3103								-		-		-	
L3108	Diode inductor	Inductor, RF, 15 turns #30E wire wound on 7/16" dia. ceramic form, slug tuned.					51-5880G5	701		1		1		1	L3108
L3109	Video filter choke	Inductor, 17.4 μh, self resonant to 30 mc ±5% wound on dummy resistor.			31	12736	92-5105	702		1		2		3	L3109, L3112, L3115
L3110	Input inductor	Same as L3101								-		-		-	
L3111	Input transformer	Same as L3102								-		-		-	
L3112	Discriminator choke	Same as L3109								-		-		-	
L3113	V3115 current limiting choke	Inductor, 1 mh, 5 ma dc, navy treated.			31	12774	92-5107	704		1		1		1	L3113
L3114	Heater choke	Reactor, RF choke, 3/16" x 5/8" form with axial leads. 1st layer 21-23 turns #24A wire wound right hand. 2nd layer 12-14 turns #24E wire wound left hand.			31	12734	92-5078P1	705		0		1		1	L3114
L3115	V3112 plate choke	Same as L3109								-		-		-	
		PLUGS AND PROBES													
P301	Video cable connector	Connector	-49190		2	83-1SP	79-5046	708		1		1		2	P301
P303	Pulse cable connector	Connector			35	Type B	79-5053G2	710		1		1		2	P303
P304	Terminal plug panel	Terminal plug panel.			28		5B1-444	714		1		1		2	P304
P304A	Plug assembly for P304	Plug, banana screw type and hardware.			35	152346	51-5701G4	715		2		4		8	P304A
		RESISTORS													
R301	Keep-alive dropping resistor	Resistor, composition, 1.3 MΩ ±10%, 1 watt, pigtail terminals.	-63288	RE 13A 340C	34	CM-1	80-5903	720		1		3		5	R301, R302

0 No spares furnished
- For spares see reference given in "Description" column

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-43ACN RADAR TRANSMITTER-RECEIVER
FOR USE WITH SO-4 RADAR EQUIPMENT

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP.		TENDER		STOCK		ALL SYMBOL DESIGNATIONS INVOLVED
									BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	
		RESISTORS (Cont'd)													
R302	Keep-alive dropping resistor	Same as R301	-63288							-		-		-	
R303	Keep-alive bleeder resistor	Resistor, composition, 500,000 Ω ±10%, 1 watt, pigtail terminals.	-63288	RE 13A 340C	34	CM-1	80-5240	722		1		3		5	R303, R304
R304	Keep-alive bleeder resistor	Same as R303	-63288							-		-		-	
R306	Transmitter bias resistor	Resistor, composition, 10,000 Ω ±10%, 2 watts, pigtail terminals.	-63474	RE 13A 340C	20	BT-2	80-5071	724		4		11		18	R306, R307, R308, R309, R310 R311, R312
R307	Transmitter bias resistor	Same as R306	-63474							-		-		-	
R308	Transmitter bias resistor	Same as R306	-63474							-		-		-	
R309	Transmitter bias resistor	Same as R306	-63474							-		-		-	
R310	Transmitter bias resistor	Same as R306	-63474							-		-		-	
R311	Transmitter bias resistor	Same as R306	-63474							-		-		-	
R312	Transmitter bias resistor	Same as R306	-63474							-		-		-	
R313	Metering resistor	Resistor, composition, 1000 Ω ±10%, 1 watt, pigtail terminals.	-63288	RE 13A 340C	34	CM-1	80-5210	728		1		2		3	R313
R314	Dropping resistor	Resistor, wirewound, 100 Ω ±5%, Style F, Grade 1, Class II.	-63676-D	RE 13A 372J	20		80-5871	729		1		2		3	R314
R3101	Mixer current decoupling resistor	Resistor, composition, 100 Ω ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 340C	34	MB-½	80-5204	734		1		2		3	R3101, R3125
R3102	V3104 cathode resistor	Resistor, composition, 150 Ω ±5%, ½ watt, pigtail terminals.	-63355	RE 13A 340C	34	MB-½	80-5514	735		4		11		18	R3102, R3106, R3109, R3111 R3113, R3115, R3126
R3103	V301 decoupling resistor	Resistor, composition, 250 Ω ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 340C	34	MB-½	80-5205	736		7		20		33	R3103, R3104, R3107, R3108, R3110, R3112, R3114, R3116, R3118, R3123, R3124, R3127,
R3104	V3105 grid decoupling resistor	Same as R3103	-63360							-		-		-	
R3105	Gain control bleeder resistor	Resistor, composition, 1000 Ω ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 340C	34	MB-½	80-5293	738		1		3		5	R3105, R3130
R3106	V3105 cathode resistor	Same as R3102	-63355							-		-		-	
R3107	V3105 screen decoupling resistor	Same as R3103	-63360							-		-		-	
R3108	V3106 grid decoupling resistor	Same as R3103	-63360							-		-		-	
R3109	V3106 cathode resistor	Same as R3102	-63355							-		-		-	
R3110	V3106 screen decoupling resistor	Same as R3103	-63360							-		-		-	
R3111	V3107 cathode resistor	Same as R3102	-63355							-		-		-	
R3112	V3107 screen decoupling resistor	Same as R3103	-63360							-		-		-	
R3113	V3108 cathode resistor	Same as R3102	-63355							-		-		-	
R3114	V3108 screen decoupling resistor	Same as R3103	-63360							-		-		-	
R3115	V3109 cathode resistor	Same as R3102	-63355							-		-		-	
R3116	V3109 screen decoupling resistor	Same as R3103	-63360							-		-		-	

- For spares see reference given in "Description" column

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-43ACN RADAR TRANSMITTER-RECEIVER
FOR USE WITH SO-4 RADAR EQUIPMENT

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP.		TENDER		STOCK		ALL SYMBOL DESIGNATIONS INVOLVED
									BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	
		RESISTORS (Cont'd)													
R3117	V3109 plate load resistor	Resistor, composition, 2000 Ω ±5%, ½ watt, pigtail terminals.	-63355	RE 13A 340C	34	MB-½	80-5212	742		1		2		3	R3117, R3136
R3118	V3109 plate decoupling resistor	Same as R3103	-63360							-		-		-	
R3119	V3110 load resistor	Resistor, composition, 3000 Ω ±5%, ½ watt, pigtail terminals.	-63355	RE 13A 340C	34	MB-½	80-5361	744		2		3		5	R3119, R3143
R3120	V3111 grid resistor	Resistor, composition, 1 MΩ ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 340C	34	MB-½	80-5244	745		1		2		3	R3120
R3121	V3111 screen bleeder res.	Resistor, composition, 60,000 Ω ±5%, 1 watt, pigtail terminals.	-63291	RE 13A 340C	34	CM-1	80-5490	746		1		2		3	R3121
R3122	V3111 screen dropping resistor	Resistor, composition, 100,000 Ω ±5%, 1 watt, pigtail terminals.	-63291	RE 13A 340C	34	CM-1	80-5301	747		2		5		8	R3122, R3132, R3144
R3123	V3104 plate decoupling resistor	Same as R3103	-63360							-		-		-	
R3124	V3105 plate decoupling resistor	Same as R3103	-63360							-		-		-	
R3125	Mixer bias resistor	Same as R3101	-63360							-		-		-	
R3126	V3112 cathode resistor	Same as R3102	-63355							-		-		-	
R3127	V3112 screen decoupling resistor	Same as R3103	-63360							-		-		-	
R3128	V3113 load resistor	Resistor, composition, 10,000 Ω ±5%, ½ watt, pigtail terminals.	-63355	RE 13A 340C	34	MB-½	80-5219	750		1		3		5	R3128, R3129
R3129	V3113 load resistor	Same as R3128	-63355							-		-		-	
R3130	V3114 cathode resistor	Same as R3105	-63360							-		-		-	
R3131	V308 grid resistor	Resistor, composition, .25 MΩ ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 340C	34	MB-½	80-5238	752		1		3		5	R3131, R3133
R3132	V3114 plate load resistor	Same as R3122	-63291							-		-		-	
R3133	V3115 grid resistor	Same as R3131	-63360							-		-		-	
R3134	V3115 plate resistor	Resistor, composition, 1 MΩ ±5%, ½ watt, pigtail terminals.	-63355	RE 13A 340C	34	MB-½	80-5331	754		1		3		5	R3134, R3137
R3135	V3115 grid bias resistor	Resistor, composition, 1800 Ω ±5%, ½ watt, pigtail terminals.	-63355	RE 13A 340C	34	MB-½	80-5709	755		1		2		3	R3135
R3136	V3115 bleeder resistor	Same as R3117	-63355							-		-		-	
R3137	V3116 plate resistor	Same as R3134	-63355							-		-		-	
R3138	AFC voltage divider resistor	Resistor, composition, 24,000 Ω ±5%, 1 watt, pigtail terminals.	-63291	RE 13A 340C	34	CM-1	80-5741	756		1		2		3	R3138
R3139	AFC voltage divider resistor	Resistor, composition, 36,000 Ω ±5%, 1 watt, pigtail terminals	-63291	RE 13A 340C	34	CM-1	80-5746	757		1		2		3	R3139
R3140	V3116 grid resistor	Resistor, composition, 220,000 Ω ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 340C	34	MB-½	80-5437	758		1		2		3	R3140
R3141	Repeller divider resistor	Resistor, composition, 2 MΩ ±10%, ½ watt, pigtail terminals.	-63355	RE 13A 340C	34	MB-½	80-5332	759		1		3		5	R3141, R3142
R3142	Repeller divider resistor	Same as R3141	-63355							-		-		-	
R3143	V3103 repeller filter resistor	Same as R3119	-63355							-		-		-	

- For spares see reference given in "Description" column

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-43ACN RADAR TRANSMITTER-RECEIVER
FOR USE WITH SO-4 RADAR EQUIPMENT

PART								SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		RESISTORS (Cont'd)													
R3144	V3111 screen dropping resistor	Same as R3122	-63291							-		-		-	
R3145	Power lead filter resistor	Resistor, composition, 50 Ω ±10%, 1 watt, pigtail terminals	-63288	RE 13A 340C	34	CM-1	80-5201	761		1		2		3	R3145
R3146		Resistor, composition, 4700 Ω ±10%, ½ watt, pigtail terminals	-63340	RE 13A 340C	34	MB-½	80-5431	762		1		2		3	R3146
		SWITCHES, INTERLOCKS AND THERMOSTATS													
S301	Transmitter-Receiver overload thermostat	Thermostatic switch, cartridge type, opens at 89°C, MC			13	4-732-RC	28-5106P2	770		1		2		4	S301
S302	Interlock	Switch, interlock, 10 a @ 125 v ac, wiping contacts, male parts silver plated			6	LD-4600	28-5072G1	771		1		1		1	S302
		TRANSFORMERS													
T301	Pulse transformer	Transformer assembly including, socket for V301 and receptacle (J303)			28	UX-9202	92-491G1	772		1		2		3	T301
T302	Filament transformer	Transformer, Filament: Pri. 115/60-400/1φ Wind. | No. Turns | Wire Size | DC Res. | Volts | Amps | Test V r.m.s. Pri. | 170 | 30E | 53 | 115 | .110 | 1780 Sec. | 131 | 19E | .460 | 7.70 | 1.3 | 1780 Pri. rated: 12.6 va (approx.) Elec. shield			28	UX-9198A	92-5156	773		1		2		3	T302
T303	Keep-alive transformer	Transformer, Plate and Filament: Pri. 115/60-400/1φ Wind. | No. Turns | Wire Size | DC Res. | Volts | Amps | Test V r.m.s. Pri. | 810¾ | 32E | 45 | 115 | .104 | 1780 Sec. #1 | 6000¾ | 40E | 3600 | 770 | .0025 | 1780 Sec. #2 | 20¼ | 18E | .066 | 2.5 | 3.0 | 1780 Pri. rated: 12 va (approx.) Elec. shield			28	UX-8942C	92-619G1	774		1		2		3	T303
T3101	Filament transformer	Transformer, Filament: Pri. 115/60/1φ Wind. | No. Turns | Wire Size | DC Res. | Volts | Amps | Test V r.m.s. Pri. | 774 | 27E | 14.7 | 115 | .39 | 1780 Sec. #1 | 48 | 14E | .054 | 6.3 | 5.1 | 1780 Sec. #2 | 48¾ | 2x22E | .030 | 6.3 | 1.2 | 1780 Pri. rated: 45.5 va (approx.) Elec. shield			28	UX-7463A	92-644G1	775		1		2		3	T3101

* - For spares see reference given in "Description" column

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-43ACN RADAR TRANSMITTER-RECEIVER
FOR USE WITH SO-4 RADAR EQUIPMENT

PART								SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		* VACUUM AND GASEOUS DISCHARGE TUBES													
V301	High frequency oscillator	Transmitter tube.			28	2J36A	90-5084			3		6		0	V301
V302	Keep-alive rectifier	Half wave rectifier.			28	RKR-72	90-5073			3		6		0	V302
V3101	Receiver switch	Duplexing tube.			19	1B24	90-5093			3		6		0	V3101
V3102	Transmitter switch	Duplexing tube.			19	724A	90-5083			3		6		0	V3102
V3103	Receiver local oscillator	Reflection type oscillator.			28	723A	90-5112			3		6		0	V3103
V3104	i-f amplifier	Television, amp. pentode.	-6AC7		29	6AC7/1852	90-5072			18		27		0	V3104, V3105, V3106, V3107, V3108, V3109, V3111, V3112, V3114
V3105	i-f amplifier	Same as V3104	-6AC7							-		-		-	
V3106	i-f amplifier	Same as V3104	-6AC7							-		-		-	
V3107	i-f amplifier	Same as V3104	-6AC7							-		-		-	
V3108	i-f amplifier	Same as V3104	-6AC7							-		-		-	
V3109	i-f amplifier	Same as V3104	-6AC7							-		-		-	
V3110	Second detector	Twin diode (metal tube).	-6H6		29	6H6	90-5048P1			4		6		0	V3110, V3113
V3111	Video - limiter	Same as V3104	-6AC7							-		-		-	
V3112	AFC i-f amplifier	Same as V3104	-6AC7							-		-		-	
V3113	Discriminator diode	Same as V3110	-6H6							-		-		-	
V3114	AFC video amplifier	Same as V3104	-6AC7							-		-		-	
V3115	AFC control tube	Gas tetrode tube.			29	2050	90-5046			2		3		0	V3115
V3116	AFC search tube	Gas control tube.			29	884	90-5095			2		3		0	V3116
		SPECIAL CABLES													
W301	Pulse cable	Cable, armored co-axial (30' min.)	RG-14/U (armored)		16	RG-14/U (armored)	73-5087P2	780		40'		80'		160'	W301
		SOCKETS AND FUSE HOLDERS													
X302	Socket for V302	Vacuum tube socket, 4 contacts, ceramic wafer, silvered contacts.			2	SS-4M	82-5016P1	784		1		1		1	X302
X3103	Socket for V3103	Vacuum tube socket, 8 contacts, mica filled.			54	9911	81-5041	786		7		7		14	X3103, X3104, X3105, X3106, X3107, X3108, C3109, X3110, X3111, X3112, X3113, X3114, X3115, X3116

0 No spares furnished
- For spares see reference given in "Description" column
* Packed in wood box - see Packing List

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-43ACN RADAR TRANSMITTER-RECEIVER
FOR USE WITH SO-4 RADAR EQUIPMENT

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		SOCKETS AND FUSE HOLDERS (Cont'd)													
X3104	Socket for V3104	Same as X3103								-		-		-	
X3105	Socket for V3105	Same as X3103								-		-		-	
X3106	Socket for V3106	Same as X3103								-		-		-	
X3107	Socket for V3107	Same as X3103								-		-		-	
X3108	Socket for V3108	Same as X3103								-		-		-	
X3109	Socket for V3109	Same as X3103								-		-		-	
X3110	Socket for V3110	Same as X3103								-		-		-	
X3111	Socket for V3111	Same as X3103								-		-		-	
X3112	Socket for V3112	Same as X3103								-		-		-	
X3113	Socket for V3113	Same as X3103								-		-		-	
X3114	Socket for V3114	Same as X3103								-		-		-	
X3115	Socket for V3115	Same as X3103								-		-		-	
X3116	Socket for V3116	Same as X3103								-		-		-	
		CRYSTALS													
Y3101	Signal mixer crystal	Crystal rectifier capsule, metal part gold-plated.	IN23		19	IN23	122-5002	790		20		40		100	Y3101, Y3102
Y3102	AFC mixer crystal	Same as Y3101								-		-		-	
		ASSEMBLIES													
Z303	Waveguide coupling assembly	Comprises RF303, RF304, and RF305.					5B1-476	794		0		1		2	Z303
		SPECIAL RESISTOR WOUND CHOKES													
LR3101	V3104 plate load	Choke, wound resistor, 17.4 μh, self resonant to 30 Mc ±5%, choke wound on 1200 Ω resistor.			31	12736	92-5097	798		1		3		5	LR3101, LR3102, LR3103, LR3104, LR3105
LR3102	V3105 plate load	Same as LR3101								-		-		-	
LR3103	V3106 plate load	Same as LR3101								-		-		-	

0 No spares furnished
- For spares see reference given in "Description" column

11-4-44

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-43ACN RADAR TRANSMITTER-RECEIVER
FOR USE WITH SO-4 RADAR EQUIPMENT

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		SPECIAL RESISTOR WOUND CHOKES (Cont'd)													
LR3104	V3107 plate load	Same as LR3101								-		-		-	
LR3105	V3108 plate load	Same as LR3101								-		-		-	
		SPECIAL RF ASSEMBLIES													
RF301	Waveguide coupling assembly	Tubing assembly.			28		5B17-112	802		0		1		2	RF301
RF302	Waveguide matching trans.	Transformer			28		5B1-38P2	803		0		1		2	RF302
RF303	RF coupling	RF coupling			28		5B1-111P2	804		0		0		0	RF303
RF305		Adaptor coupling.			28		5B1-140P2	804A		0		0		0	RF305
RF3101	RF System	Guide assembly.			28		5B33-181	805		0		1		2	RF3101
RF3102	Input assembly	Dual mixer and local oscillator assembly.			28		5B30-150	806		0		1		2	RF3102
		SPECIAL TUNED CIRCUIT ASSEMBLIES													
TC3101	AFC discriminator	Discriminator assembly.			28		5B54-265	809		1		1		1	TC3101
		MECHANICAL SPARES													
	Cap for J302	Cap and chain assembly.			131		51-5851	824		0		1		2	
	Terminal assembly for V3103	Grid cap plus lead.			156		27-5173	825		0		1		2	
		Boot-air duct.			132		5B1-120P1	826		1		2		4	
		Shock mount assembly.			134		5B26-421	829		1		1		2	
		Shoulder screw			155		5B3-12P1	830		0		6		6	
		Captive screw			135		5B36-211P1	831		0		1		2	
		Captive screw			145		3B10-64P1	832		0		1		2	
		Gasket			17		5B1-26P1	834		1		2		4	
		Gasket			132		5B1-127P1	836		1		2		4	
		Body air valve			136		3C18-195P1	852		0		1		1	
		Valve cap			156		94-5068G1	853		0		1		1	

0 No spares furnished
- For spares see reference given in "Description" column

11-4-44

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-43ACN RADAR TRANSMITTER-RECEIVER
FOR USE WITH SO-4 RADAR EQUIPMENT

PART								SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		MECHANICAL SPARES (Cont'd)													
		Gasket			132		5B1-128P1	837		1		2		4	
		Gasket			147		5B3-18P1	838		1		2		4	
		Gasket			130		87-5049P1	839		2		4		8	
		Felt washer			137		5B6-148P1	840		1		2		4	
		Tube lock			117		88-5078P3	841		1		1		1	
		Gasket			17		5B16-107P1	842		1		2		4	
		Shutter			142		5B36-240	843		0		1		1	
		Retainer - shutter			142		5B36-241	844		0		1		1	
		Retainer - clamp			142		5B36-186	845		0		1		1	
		Pivot			142		5B36-234	846		0		1		1	
		Connector			142		5B36-238	847		0		1		1	
		Link			142		5B36-237	848		0		1		1	
		Arm			142		5B44-229	849		0		1		1	
		Washer			142		5B36-239	850		0		1		1	
		Bushing			141		4-5024	851		1		2		4	

0 no spares furnished

11-4-44

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-55AEM PLAN POSITION INDICATOR

PART								SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		NAVY TYPE CRP-55AEM PLAN POSITION INDICATOR													
		Plan Position Indicator	-55AEM		28	WX-5244		901		0		0		1	
		MOTORS AND SYNCHRO UNITS													
B401		Motor, synchro, Mark IV, Model 1A, Size 5F, 115/90 v, 60~	-21959		15	Type 5F 21767	115-5002	906		1		2		3	B401
		CAPACITORS													
C401	V401A trigger capacitor	Capacitor, mica, .00025 mfd., ±10%, 500 v dc wkg.	-48690-10	RE 48A 148C RE 48A 154F	28		35-5084	911		1		1		1	C401
C402	V401 timing capacitor	Capacitor, mica, .002 mfd., ±5%, 500 v dc wkg.	-48856-5	RE 48A 143F RE 48A 154F	28		35-5039	912		1		1		1	C402
C403A B C	V401B cathode by-pass capacitor C-Bias filter capacitor V401B cathode by-pass capacitor	Capacitor, paper, 3 x .1 mfd., ±20%, 600 v dc wkg.	-48709-A20	RE 48A 138C RE 48A 488D	28		35-5092	913		1		2		3	C403
C404	V402A grid capacitor	Capacitor, paper, .02 mfd., +20%-10%, 600 v dc wkg.	CP2-F203MK	JAN-C-5	33	PK24A	35-5090P2	914		1		3		5	C404, C416
C405	Sweep starting capacitor	Capacitor, mica, .000025 mfd., ±5%, 500 v dc wkg.	CM20-250J	JAN-C-5	32	MCW-1406-5	35-5122	915		1		1		2	C405, C406
C406	Sweep starting capacitor	Same as C405								-		-		-	
C407	Sweep capacitor	Capacitor, silver mica, .00022 mfd., ±2%, 500 v dc wkg.	CM20-221G	JAN-C-5	31		35-5123	917		1		1		1	C407
C408	Sweep capacitor	Capacitor, silver mica, .0014 mfd., ±2%, 500 v dc wkg.	CM35-142G	JAN-C-5	31		35-5099	918		1		1		1	C408
C409	Sweep capacitor	Capacitor, silver mica, .006 mfd., ±3%, 500 v dc wkg.			32	MWSW-5-26-3	35-5124	919		1		1		1	C409
C410	V403 cathode by-pass capacitor	Capacitor, mica, .001 mfd., ±10%, 500 v dc wkg.	-48983-10	RE 48A 143F RE 48A 154F	28	C-1210-10	35-5036	920		1		1		1	C410
C411	Filter capacitor	Capacitor, paper, 4 mfd., ±10%, 600 v dc wkg.	CP70-F405KK	JAN-C-5	33	2528-3	35-5094	921		1		2		3	C411
C416	V402B grid capacitor	Same as C404								-		-		-	
C417	V404B grid capacitor	Capacitor, paper, .01 mfd., +20%-10%, 600 v dc wkg.	CP2-G103MK	RE 13A 488D	33	PK24A	35-5089	927		3		9		15	C417, C418, C419, C420, C422, C423
C418	V405A grid capacitor	Same as C417								-		-		-	
C419	V405B grid capacitor	Same as C417								-		-		-	
C420	V407 cathode capacitor	Same as C417								-		-		-	

0 No spares furnished
- For spares see reference given in "Description" column

11-4-44

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-55AEM PLAN POSITION INDICATOR

PART								SPARES							
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
CAPACITORS (Cont'd)															
C421	Intensity control by-pass cap.	Capacitor, paper, 2 mfd., ±10%, 600 v dc wkg.	-48403-B	RE 48A 129H RE 13A 488D	9	DYR-6200	35-5007	931		2		4		8	C421, C427, C429
C422	V406A grid capacitor	Same as C417								-		-		-	
C423	V406B grid capacitor	Same as C417								-		-		-	
C426A B	High voltage filter capacitor High voltage filter capacitor	Capacitor, paper, .1 x.1 mfd., ±10%, 7000 v dc wkg.		RE 48A RE 48A 488D	15	25F774	35-5091	934		1		3		5	C426, C430
C427	V402A plate capacitor	Same as C421	-48403B-10							-		-		-	
C428	Relative bearing flasher filter capacitor	Capacitor, mica, .001 mfd., ±10%, 300 v dc wkg.	-481070C-10	RE 48A 154F	32	MDCW-1427-10	35-5086	936		1		1		1	C428
C429	L405 supply by-pass capacitor	Same as C421	-48403B-10							-		-		-	
C430	High voltage filter output cap.	Same as C426								-		-		-	
TERMINAL STRIPS AND MISCELLANEOUS ELECTRICAL PARTS															
E401	Terminal strip for L405	Terminal strip, barrier type, 2 solder terminals with 3-40 x 3/16" binder head screws.			21	2-140-W	47-5047P2	942		0		0		1	E401
		Insulator, ceramic stand-off, ¼" long, ¼" dia., tapped 6-32, ¼" deep at each end.			40	1402	22-5045P2	947		1		1		2	
		Insulator, ceramic stand-off, 1" long, ¼" dia. tapped 8-32, 3/8" deep at each end.			40	1000	22-5015P2	949		1		1		2	
		Insulator, ceramic stand-off, 1¼" long, ¼" dia., tapped 6-32, ¼" deep at each end.			40	1002	22-5017P1	950		1		1		2	
FUSES															
F401	Fuse for T402 primary	Fuse, 1a, 250 v, length 2", ferrule dia. 9/16".		17-F-2	57	25001	26-5035	953		20		40		100	F401
F403	Synchro supply fuse	Fuse, 6 a, 250 v, length 2", ferrule dia. 9/16".		17-F-2	57	25006	26-5043	955		10		20		50	F403
F404	Fuse T401-2-3 primary	Fuse, 2 a, 250 v, length 2", ferrule dia. 9/16".		17-F-2	57	25002	26-5036	956		10		20		50	F404

0 No spares furnished
- For spares see reference given in "Description" column

11-4-44

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-55AEM PLAN POSITION INDICATOR

PART								SPARES							
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
DIAL AND PILOT LIGHTS															
I401	PPI dial light	Dial light, 6 volts, 1 cp.		TB-11	15	Mazda #44	77-5009	960		8		16		24	I401, I402, I403, I404
I402	PPI dial light	Same as I401								-		-		-	
I403	PPI dial light	Same as I401								-		-		-	
I404	PPI dial light	Same as I401								-		-		-	
RECEPTACLES															
J401	Indicator input jack assy.	Jack panel assembly.			28		34C-5	970		1		1		2	J401
J401A	Indicator chassis jack	Receptacle, jack, banana type.			35	152347	51-5701G3	971		2		4		8	J401A
J402	PPI input jack assembly	Jack panel assembly.			28		3C1-322	972		1		1		2	J402
J402A	PPI jack assembly	Jack, banana rivet type and hdwe.			35	152073	51-5804G1	973		2		4		8	J402A
CONTACTORS AND RELAYS															
K401	Synchronizing relay for synchro	Relay, DPDT, 24 v dc coil contacts rated for 5 a, @ 115 v 400 ~.			75	BO6D35	71-5015	979		1		2		3	K401
INDUCTORS AND CHOKES															
L401	Sweep choke	Reactor, 3 hy. min. ind. @ 3[illegible] dc and 3 v r.m.s., 60 ~ ac. Test 1[illegible] v r.m.s. 2500 turns #34E wire, 250 Ω max. dc res. Wt. 15 ozs.		RE 13A 554D	28	UX-7725	92-402	983		1		1		1	L401
L405	Focus coil assembly	Reactor, magnetic focus coil assy.			28		3C36-297	987		1		1		2	L405
L406	Deflection coil	Reactor, magnetic deflection coil assy.			28		92-5085P4	988		1		1		2	L406
L406A		Deflection coil brush and spring.			15	BA36CA20	103-5010	989		2		6		10	L406A
L406B		Deflection coil brush cap.			28		3C2-57P1	990		1		4		6	L406B
L407	Video compensating choke	Reactor, RF choke 300 μh min. ind. @ 5 ma dc.			31	12730	92-5079P2	991		1		1		1	L407
PLUGS AND PROBES															
P401	Indicator input plug assembly	Plug panel assembly.			28		34C-2	1000		1		1		2	P401
P401A		Plug, banana, screw type and hardware.			35	152346	51-5701G4	1001		2		4		8	P401A
P402	PPI input plug assembly	Plug panel assembly.			28		3C1-321	1002		1		1		2	P402
P402A		Plug, banana, rivet type and hardware.			35	152015	51-5803G1	1003		2		4		8	P402A

0 No spares furnished
- For spares see reference given in "Description" column

11-4-44

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-55AEM PLAN POSITION INDICATOR

PART								SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		RESISTORS													
R401	V401A grid resistor	Resistor, composition, 25,000 Ω ±5%, 1 watt, pigtail terminals.	-63291	RE 13A 340C	34	CM-1	80-5225	1008		1		2		3	R401
R402	V401A grid resistor	Resistor, composition, 75,000 Ω ±5%, 1 watt, pigtail terminals.	-63291	RE 13A 340C	34	CM-1	80-5233	1009		1		2		3	R402
R403	V401A grid resistor	Resistor, composition, 390,000 Ω ±5%, 1 watt, pigtail terminals.	-63291	RE 13A 340C	34	CM-1	80-5474	1010		1		2		3	R403
R404	V401A plate resistor	Resistor, composition, 22,000 Ω ±5%, 1 watt, pigtail terminals.	-63291	RE 13A 340C	34	CM-1	80-5224	1011		3		9		15	R404, R405, R406, R407, R408, R409
R405	V401A plate resistor	Same as R404	-63291							-		-		-	
R406	V401A plate resistor	Same as R404	-63291							-		-		-	
R407	V401A plate resistor	Same as R404	-63291							-		-		-	
R408	V401A plate resistor	Same as R404	-63291							-		-		-	
R409	V401A plate resistor	Same as R404	-63291							-		-		-	
R410	V401B plate resistor	Resistor, composition, 30,000 Ω ±5%, 1 watt, pigtail terminals.	-63291	RE 13A 340C	34	CM-1	80-5229	1015		1		3		5	R410, R411
R411	V401B plate resistor	Same as R410	-63291							-		-		-	
R412	V401B grid resistor	Resistor, composition, 50,000 Ω ±5%, 1 watt, pigtail terminals.	-63291	RE 13A 340C	34	CM-1	80-5262	1017		1		2		3	R412
R413	V402A plate resistor	Resistor, composition, 150,000 Ω ±5%, ½ watt, pigtail terminals.	-63355	RE 13A 340C	34	MB-½	80-5312	1018		1		2		3	R413
R414	Sweep damping resistor	Resistor, composition, 15,000 Ω ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 340C	34	MB-½	80-5220	1018A		1		2		3	R414
R415	V402A grid resistor	Resistor, composition, 500,000 Ω ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 340C	34	MB-½	80-5243	1019		1		3		5	R415, R451
R416	V402A plate resistor	Resistor, composition, .47 MΩ ±5%, 1 watt, pigtail terminals.	-63291	RE 13A 340C	34	CM-1	80-5507	1020		1		2		3	R416
R417	Sweep shaping resistor	Resistor potentiometer 20,000 Ω ±10% 2 watt, linear taper.		RE 13A 372J	34	Type J	40-5134P1	1021		1		3		5	R417
R418	Sweep shaping resistor	Resistor, composition, 2000 Ω ±5%, ½ watt, pigtail terminals.	-63355	RE 13A 340C	34	MB-½	80-5212	1022		1		2		3	R418
R419	Sweep centering resistor	Resistor, composition, 100 Ω ±5%, ½ watt, pigtail terminals.	-63355	RE 13A 340C	34	MB-½	80-5203	1023		1		2		3	R419
R420	Sweep centering resistor	Resistor, composition, 1000 Ω ±5%, ½ watt, pigtail terminals.	-63355	RE 13A 340C	34	MB-½	80-5209	1024		1		3		5	R420, R495
R421	Sweep centering control	Resistor, potentiometer, wirewound, 3000 Ω ±10%, 25 watts, linear taper, special shaft.		RE 13A 492C	8	PW-25-3000	40-5033	1025		1		3		5	R421
R422	V403 cathode resistor	Resistor, wirewound, 400 Ω±5%, Style E, Grade 1, Class II.	-63982-E	RE 13A 372J Style E	28		80-5469	1026		1		2		3	R422
R423	Sweep length control	Resistor, potentiometer, wirewound, 500 Ω ±10%, 25 watts, linear taper, spec. shaft.		RE 13A 492C	20	PW-25-500	40-5032P1	1027		1		3		5	R423
R424	Voltage divider resistor	Resistor, composition, 10,000 Ω ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 340C	34	MB-½	80-5218	1028		2		5		8	R424, R437, R489
R425	Voltage divider resistor	Resistor, composition, 100,000 Ω ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 340C	34	MB-½	80-5235	1029		3		8		13	R425, R449, R484, R486, R490
R426	Voltage divider resistor	Resistor, composition, 30,000 Ω ±10%, 1 watt, pigtail terminals.	-63288	RE 13A 340C	34	CM-1	80-5228	1030		3		9		15	R426, R427, R428, R465, R466, R467
R427	Voltage divider resistor	Same as R426	-63288							-		-		-	

- For spares see reference given in "Description" column

11-4-44

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-55AEM PLAN POSITION INDICATOR

PART								SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		RESISTORS (Cont'd)													
R428	Voltage divider resistor	Same as R426	-63288							-		-		-	
R429	V401B bias control	Resistor, potentiometer, 10,000 Ω ±10%, 3 watts, linear taper, spec. shaft.		RE 13A 492C	8	P58-W	40-5023P2	1032		1		3		5	R429
R430	Voltage divider resistor	Resistor, composition, 25,000 Ω ±10%, 1 watt, pigtail terminals.	-63288	RE 13A 340C	34	CM-1	80-5227	1033		1		2		3	R430
R431	Voltage divider resistor	Resistor, composition, 5000 Ω ±10%, 1 watt, pigtail terminals.	-63288	RE 13A 340C	34	CM-1	80-5216	1034		3		9		15	R431, R432, R433, R434, R435, R436
R432	Voltage divider resistor	Same as R431	-63288							-		-		-	
R433	Voltage divider resistor	Same as R431	-63288							-		-		-	
R434	Voltage divider resistor	Same as R431	-63288							-		-		-	
R435	Voltage divider resistor	Same as R431	-63288							-		-		-	
R436	Voltage divider resistor	Same as R431	-63288							-		-		-	
R437	Voltage divider resistor	Same as R424	-63360							-		-		-	
R438	Voltage divider resistor	Resistor, composition, 50,000 Ω ±5%, ½ watt, pigtail terminals.	-63355	RE 13A 340C	34	MB-½	80-5376	1038		1		2		3	R438
R439	Trigger line terminating resistor	Resistor, composition, 68 Ω ±10%, ½ watt.	-63360	RE 13A 340C	34	MB-½	80-5259	1039		1		2		3	R439
R440	Voltage divider resistor	Resistor, wirewound, 10,000 Ω ±5%, Style D, Grade 1, Class II.	-63090-E	RE 13A 372J	18		80-5031	1040		1		2		3	R440
R441	PPI dial lights control	Resistor, potentiometer, wirewound, 15 Ω ±10%, 25 watts, linear taper, special shaft.		RE 13A 492C	8	PW-25-15	40-5028P1	1041		1		3		5	R441
R442	V402B grid resistor	Resistor, composition, 500,000 Ω ±5%, ½ watt, pigtail terminals.	-63355	RE 13A 340C	34	MB-½	80-5242	1042		1		2		3	R442
R443	V402B plate resistor	Resistor, composition, 100,000 Ω ±10%, 1 watt, pigtail terminals.	-63288	RE 13A 340C	34	CM-1	80-5234	1043		2		6		10	R443, R444, R445, R446
R444	V402B plate resistor	Same as R443	-63288							-		-		-	
R445	V402 plate resistor	Same as R443	-63288							-		-		-	
R446	V402B plate resistor	Same as R443	-63288							-		-		-	
R447	V404A grid resistor	Resistor, composition, 25,000 Ω ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 340C	34	MB-½	80-5226	1045		1		3		5	R447, R463
R448	V404A plate resistor	Resistor, composition, .25 MΩ ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 340C	34	MB-½	80-5238	1046		1		2		3	R448
R449	V404B grid resistor	Same as R425	-63360							-		-		-	
R450	V404B plate resistor	Resistor, composition, 15,000 Ω±10%, 1 watt, pigtail terminals.	-63288	RE 13A 340C	34	CM-1	80-5222	1048		1		2		3	R450
R451	V401A grid resistor	Same as R415	-63360							-		-		-	
R452	V405A plate resistor	Resistor, composition, 5000 Ω ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 340C	34	MB-½	80-5215	1049		1		2		3	R452
R453	V405B plate resistor	Resistor, composition, 12,000 Ω ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 340C	34	MB-½	80-5256	1050		1		2		3	R453

- For spares see reference given in "Description" column

11-4-44

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-55AEM PLAN POSITION INDICATOR

PART								SPARES						
								EQUIP.		TENDER		STOCK		
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		RESISTORS (Cont'd)													
R454	Voltage divider resistor	Resistor, composition, 20,000 Ω ±10%, 1 watt, pigtail terminals.	-63288	RE 13A 340C	34	CM-1	80-5223	1050A		1		2		3	R454
R455	Range mark amplitude control	Resistor, potentiometer, 10,000 Ω ±5%, 2.5 watts, linear taper, spec. shaft.		RE 13A 492C	81	WI-10M	40-5004P6	1051		1		3		5	R455
R456	V405B grid resistor	Resistor, composition, 1 MΩ ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 340C	34	MB-½	80-5244	1052		1		2		3	R456
R457	V407 cathode resistor	Resistor, composition, 1000 Ω ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 340C	34	MB-½	80-5293	1053		1		2		3	R457
R458	Intensity limiting resistor	Resistor, composition, 50,000 Ω ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 340C	34	MB-½	80-5230	1054		1		2		3	R458
R459	Intensity limiting resistor	Resistor, potentiometer, wirewound, 15,000 Ω ±10%, 4 watts, linear taper, special shaft.		RE 13A 492C	8	P10-W	40-5025P1	1055		1		6		10	R459, R468
R460	V403 plate resistor	Resistor, composition, 50 Ω ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 340C	34	MB-½	80-5260	1056		1		2		3	R460
R461	Voltage divider resistor	Resistor, composition, 25,000 Ω ±5%, ½ watt, pigtail terminals.	-63355	RE 13A 340C	34	MB-½	80-5387	1056A		1		2		3	R461
R462	V406A cathode resistor	Resistor, composition, 100 Ω ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 340C	34	MB-½	80-5204	1057		1		3		5	R462, R483
R463	Relative bearing flasher filter resistor	Same as R447	-63360							-		-		-	
R465	Focus current limiting resistor	Same as R426	-63288							-		-		-	
R466	Focus current limiting resistor	Same as R426	-63288							-		-		-	
R467	Focus current limiting resistor	Same as R426	-63288							-		-		-	
R468	Focus control	Same as R459								-		-		-	
R469	Voltage divider resistor	Resistor, composition, 30,000 Ω ±5%, ½ watt, pigtail terminals.	-63355	RE 13A 340C	34	MB-½	80-5352	1060		1		2		3	R469
R470	High voltage bleeder resistor	Resistor, composition, 500,000 Ω ±10%, 1 watt.	-63288	RE 13A 340C	34	CM-1	80-5240	1061		6		17		28	R470, R471, R472, R473, R474, R475, R476, R477, R478, R479, R480
R471	High voltage bleeder resistor	Same as R470	-63288							-		-		-	
R472	High voltage bleeder resistor	Same as R470	-63288							-		-		-	
R473	High voltage bleeder resistor	Same as R470	-63288							-		-		-	
R474	High voltage bleeder resistor	Same as R470	-63288							-		-		-	
R475	High voltage bleeder resistor	Same as R470	-63288							-		-		-	
R476	High voltage bleeder resistor	Same as R470	-63288							-		-		-	
R477	High voltage bleeder resistor	Same as R470	-63288							-		-		-	
R478	High voltage bleeder resistor	Same as R470	-63288							-		-		-	
R479	High voltage bleeder resistor	Same as R470	-63288							-		-		-	
R480	High voltage bleeder resistor	Same as R470	-63288							-		-		-	
R481	High voltage filter resistor	Resistor, composition, 250,000 Ω ±10%, 1 watt, pigtail terminals.	-63288	RE 13A 340C	34	CM-1	80-5237	1065		1		3		5	R481, R482

- For spares see reference given in "Description" column

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-55AEM PLAN POSITION INDICATOR

PART								SPARES						
								EQUIP.		TENDER		STOCK		
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		RESISTORS (Cont'd)													
R482	High voltage filter resistor	Same as R481	-63288							-		-		-	
R483	Video line terminating resistor	Same as R462	-63360							-		-		-	
R484	V406A grid resistor	Same as R425	-63360							-		-		-	
R485	V406A plate resistor	Resistor, composition, 2500 Ω ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 340C	34	MB-½	80-5213	1067		1		2		3	R485
R486	V406B grid resistor	Same as R425	-63360							-		-		-	
R487	V406B plate resistor	Resistor, composition, 3000 Ω ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 340C	34	MB-½	80-5214	1069		1		2		3	R487
R488	IFF line terminating resistor	Resistor, composition, 50 Ω ±5%, ½ watt, pigtail terminals.	-63355	RE 13A 340C	34	MB-½	80-5200	1070		1		2		3	R488
R489	Voltage divider resistor	Same as R424	-63360							-		-		-	
R490	Voltage divider resistor	Same as R425	-63360							-		-		-	
R491	Voltage divider resistor	Resistor, composition, 36,000 Ω ±10%, 1 watt, pigtail terminals.	-63288	RE 13A 340C	34	CM-1	80-5388	1071		2		5		8	R491, R492, R493
R492	Voltage divider resistor	Same as R491	-63288							-		-		-	
R493	Relative bearing flasher voltage divider	Same as R491	-63288							-		-		-	
R494A B	Tune set control	Resistor, dual potentiometer, wirewound, each section, 20,000 Ω ±10%, 3 watts, linear taper, special shaft.		RE 13A 492C	8	DP-58W	40-5026	1073		1		3		5	R494
R495	Sweep centering resistor	Same as R420	-63355							-		-		-	
R496	Receiver tune limiting resistor	Resistor, composition, 50,000 Ω ±10%, 1 watt, pigtail terminals.	-63288	RE 13A 340C	34	CM-1	80-5231	1075		1		2		3	R496
R497	Receiver tune control	Resistor, potentiometer, 100,000 Ω ±10%, 2 watts, linear taper, spec. shaft.		RE 13A 492C	34	Type "C"	40-5027	1076		1		3		5	R497
R498	Receiver gain control	Resistor, potentiometer, wirewound, 10,000 Ω ±10%, 50 w left hand taper, 2000 Ω at 50% rotation, spec. shaft.		RE 13A 492C	8		40-5024p1	1077		1		3		5	R498
R499	Voltage divider resistor	Resistor, composition, 2000 Ω ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 340C	34	MB-½	80-5211	1078		1		2		3	R499
		SWITCHES													
S401 S401E	Range switch	Switch, rotary, 4 ceramic wafers, silvered wiping contacts, shorting type rotor blades as follows: First wafer--One single pole, circuit opens in third position. S401E- Standard Arrangement.			26	Type "H"	28-5069G1	1085		1		1		1	S401

- For spares see reference given in "Description" column

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-55AEM PLAN POSITION INDICATOR

PART								SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		SWITCHES (Cont'd)													
S401D F		Second wafer--Two single pole, three circuit groups. S401D - Standard Arrangement S401F - Special arrangement open in 3rd position.													
S401B		Third wafer--One single pole, 3 circuit contact groups and 3 resistor support lugs. S401B - Standard arrangement.													
S401A C		Fourth wafer--Two single pole, three circuit contact groups. S401A - Standard arrangement. S401C - Special arrangement.													
S402	Motor switch	Switch, lever type, DPDT, 1 break per circuit, current rated for 10 amps, @ 110 v ac.			36		28-5071P1	1086		1		1		1	S402
S404	Normal emergency switch	Switch, dual toggle type SPDT, front unit to "make" before rear unit "breaks", front unit 3 a @ 115 v dc. Rear unit 1 amp. @ 115 v dc.			4	21490-BK	28-5075	1088		1		1		1	S404
S405	Modulation switch	Switch, push button type, 1 contact normally open, 1 contact normally closed, wiping contact rated 1 a @ 115 v dc with red & black push buttons.			28		28-5070P2	1089		1		1		1	S405
S408	Synchronizing switch	Switch, roller leaf, super sensitive, SPST, norm. open rated 10 a, 115 v ac.			25	4-MZGW-21	28-5068	1091		1		1		1	S408
		TRANSFORMERS													
T401	General filament transformer	Transformer, filament: Pri. 115/60/1Ø Wind / No. Turns / Wire Size / DC Res. / Volts / Amps / Test V r.m.s Pri. 458½ 24E 6 115 .85 1780 Sec. #1 26½ 13E .3 6.3 4.7 1780 Sec. #2 26½ 20E .15 6.3 .6 1780 Pri. rated, 40 va (approx.) Elec. shield.			28	UX-7319A	92-670G1	1095		1		2		3	T401
T402	High voltage transformer	Transformer, plate and filement: Pri. 115/60/1Ø Wind / No. Turns / Wire Size / DC Res. / Volts / Amps / Test V r.m.s. Pri. 520 28E 2Ø 115 .165 1780 Sec. #1 12 16E .080 2.5 3.0 11kv Sec. #2 22,000 41HE 17,000 4580 .002 Pri. rated, 19 va (approx.) Elec. shield.			28	UX-7320A	92-671G1	1096		1		2		3	T402

4-g

11-4-44

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-55AEM PLAN POSITION INDICATOR

PART								SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		* VACUUM AND GASEOUS DISCHARGE TUBES													
V401A B	Multivibrator tube Multivibrator tube	Twin triode low MU amplifier.	6SN7-GT		29	6SN7-GT	90-5051			10		15		0	V401,V402,V404,V405,V406
V402A B	Sweep generator tube Marker oscillator tube	Same as V401	6SN7-GT							-		-		-	
V403	Magnetic sweep tube	Transmitting beam power amplifier.	807		29	807	90-5039			2		3		0	V403
V404A B	Range mark shaping tube Range mark shaping tube	Same as V401	6SN7-GT							-		-		-	
V405A B	Range mark shaping tube Range mark shaping tube	Same as V401	6SN7-GT							-		-		-	
V406A B	Video amplifier tube Video amplifier tube	Same as V401	6SN7-GT							-		-		-	
V407	Plan Position Indicator tube	5" magnetic deflection, long persistance CR tube.			15	5FP7	90-5076			3		6		0	V407
V408	High voltage rectifier tube	Half wave rectifier.	3B24		28	3B24	90-5100			2		3		0	V408
		SOCKETS AND FUSE HOLDERS													
X401	Socket for V401	Vacuum tube socket, 8 contacts, ceramic wafer, silvered contacts.			2	SS-8M	82-5012P2	1110		4		4		7	X401,X402,X404,X405,X406, X407,X408
X402	Socket for V402	Same as X401								-		-		-	
X403	Socket for V403	Vacuum tube socket, 5 contacts, ceramic wafer, silvered contacts.			2	SS-5M	82-5017P1	1112		1		1		1	X403
X404	Socket for V404	Same as X401								-		-		-	
X405	Socket for V405	Same as X401								-		-		-	
X406	Socket for V406	Same as X401								-		-		-	
X407	Socket for V407	Same as X401								-		-		-	
X408	Socket for V408	Same as X401								-		-		-	
X409	Socket for V409	Vacuum tube socket, 4 contacts, ceramic wafer, silvered contacts.			2	SS-4M	82-5016P2	1114		1		1		1	X409
X410	Socket for I401	Socket, pilot lamp, bayonet type.			3	1787	81-5034	1115		2		2		3	X410,X411,X412
X411	Socket for I402	Same as X410								-		-		-	
X412	Socket for I403	Same as X410								-		-		-	
		SPECIAL TUNED CIRCUIT ASSEMBLIES													
TC401	One mile marker oscillator	Inductor, 1 c. Tuned to 81.96 KC adj. iron core.			31	12527	92-5084	1126		1		2		3	TC401
TC402	Four mile marker oscillator	Inductor, 1 c. Tuned to 16.4 KC adj. iron core.			31	12716	92-5092	1127		1		2		3	TC402

Ø No spares furnished
* Packed in wooden boxes - see Packing List
- For spares see reference given in "Description" column

4-h

11-4-44

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-55AEM PLAN POSITION INDICATOR

PART								SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		SPECIAL TUNED CIRCUIT ASSEMBLIES (Cont'd)													
TC403	Fifteen mile marker oscillator	Inductor, 1 c. Tuned to 4.1 KC adj. iron core.			31	12715	92-5093	1128		1		2		3	TC403
		MECHANICAL SPARES													
		Tube clip			146		3C8-190P1	1133		0		0		1	
		Tube pad (PPI)			17		3C1-23P1	1135		1		1		2	
		Grid clips			123		27-5124P2	1136		0		0		1	
		Grid clips			123		27-5024P2	1137		0		0		1	
		Window assembly			124		3C25-125P1	1138		0		1		2	
		Window gasket			126		3C7-298P1	1139		1		2		4	
		Window seal ring			28		3C7-301P1	1140		0		1		1	
		Terminal			127		27-5193P1	1141		0		0		1	
		Driver dial assembly			28		3C46-363	1145		0		1		2	
		Dial assembly			28		3C27-233	1146		0		1		2	
		Cable assembly for V407 anode connection			62		51-5699G1	1147		1		1		2	
		Motor coupling			66	J-1211-2	3C1-351	1149		0		1		1	
		Lever bar assembly			28		3C5-258	1150		0		1		2	
		Rubber diaphragm			126		3C7-299P1	1151		1		2		4	
		Captive screw			145		3C1-25P1	1152		0		1		1	
		Captive screw			128		3C1-25P2	1153		0		1		1	
		Gasket			77		3C7-354P1	1154		1		2		4	
		Gasket			77		3C7-354P2	1154A		1		2		4	
		Gasket			77		3C7-239P4	1155		1		2		4	
		Gasket			17		3C7-126P1	1156		1		2		4	
		Gasket			126		3C7-189P1	1157		1		2		4	
		Gasket (PPI)			147		3C1-72P1	1158		1		2		4	
		Gasket			77		3C7-239P1	1159		1		2		4	
		Gasket			77		3C7-239P2	1160		1		2		4	
		Gasket			17		34C-9P1	1161		1		2		4	
		Gasket			17		34C-10P1	1162		1		2		4	
		Captive screw			28		3C7-382P2	1163		0		1		1	
		Captive nut			147		3C6-118	1164		0		1		1	

11-4-44

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-55AEM PLAN POSITION INDICATOR

PART								SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		MECHANICAL SPARES (Cont'd)													
		Rubber gauntlet			63		3C7-220P1	1165		1		2		4	
		Lever bar handle			28		3C5-260 P2	1166		0		1		1	
		Slider foot			139		3C6-124P1	1169		0		0		2	
		Lever hook block assembly			122		3C8-180	1170		0		1		2	
		Air valve assembly			146		3C18-194	1171		0		1		2	
		Knob (large)			123		3C23-103	1172		1		2		3	
		Hand crank assembly					3C22-208	1173		0		1		2	
		Handle motor switch			134		3C7-218P1	1174		0		1		1	
		Plug, threaded			160		3C5-186P2	1175		0		1		1	
		Potentiometer waterproof assembly			148		3C41-344	1176		0		1		2	
		Knob (small)			56		3C24-102	1177		1		1		2	
		Red moulded plastic push button marked "stop" with inserts, screws & lock-washers.			123		3C7-340P1	1178		0		1		1	
		Black moulded plastic push button marked "start" with inserts, screws and lockwashers.			123		3C7-340P2	1179		0		1		1	
		Grommet			126		3K2-117P1	1180		1		2		4	
		Fur trimmed felt viewing hood			160		3C-415	1181		1		0		0	
		Plexi-glas storm window					3C7-320P2	1182		1		2		3	
		Bleeder panel assembly			139		34C-35	1183		1		2		3	

11-4-44

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-66AGS ANTENNA ASSEMBLY

PART								SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		NAVY TYPE CRP-66AGS ANTENNA ASSEMBLY													
		Antenna Assembly			28	RX-1303		1201		0		0		2	
		MOTORS AND SYNCHRO UNITS													
B510		Motor, synchro 115 v 60~	5F		15	212767	115-5002			1		2		3	B510
B511		Motor, antenna drive 115 v dc with reduction gear			11	47665	115-5157	1211		1		2		3	B511
B511A		Set (2) brushes & spring assembly			11		103-5023	1212		5		10		20	B511A
B511B		Set (2) brush holder cap			11		103-5024	1213		2		4		6	B511B
		TERMINAL STRIPS & MISCELLANEOUS ELECTRICAL PARTS													
E514	Terminal strip for synchro	Terminal strip, barrier type, 12 solder terminals with 6-32 x ¼" binder head screws			21	12-141-3/4W	47-5048P3	1225		0		0		2	E514, E515
E515	Terminal strip for drive motor and synchro	Same as E514								-		-		-	
		RECEPTACLES													
J501	Phone connection	Phone jack			28	9S5004L	76-5004	1232		*		*		*	For spares see S506
		SWITCHES, INTERLOCKS & THERMOSTATS													
S501	Synchronizing switch	Switch, roller leaf, SPDT, contacts rated 10 a, 115 v ac			25	NBZW-21	28-5067	1250		1		2		3	S501, S504, S505
S504	Flash switch	Same as S501								-		-		-	
S505	Flash switch	Same as S501								-		-		-	
S506		Circuit switch and phone jack assembly			28		51-5878G1	1255		1		1		1	S506
		ASSEMBLIES													
Z501	Radio interference filter	Filter, radio interference, for 20 a, 115 v ac, composed of two separate "PI" sections consisting of 4 capacitors 1.0 mfd., 600 v dc wkg. & 2 coils each wound in 2 layers with 17 turns per layer of #12 double glass insulated copper wire on powered iron core. Coil resistance .01 Ω ±10%			28		92-5139	1260		0		1		2	Z501
		MECHANICAL SPARES													
		Cover screw assembly			168	8M-122	18-5098P2	1265		2		2		3	
		Retaining ring, free dia., .461 x .035 thick			152	#50B	87-5047P1	1266		2		4		6	

0 No spares furnished
- For spares see reference given in "Description" column
* For spares see reference given in "All Symbols Designations" column

11-4-44

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-66AGS ANTENNA ASSEMBLY

PART								SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		MECHANICAL SPARES (Cont'd)													
		Retaining ring			152	#37 Type B	87-5047P8	1267		2		4		6	
		Retaining ring, zinc plated			152	#87 Type A	87-5047P21	1268		2		4		6	
		Retaining ring steel			152	#100 Type B	87-5047P15	1269		2		4		6	
		Rotary joint assembly			45		51-5973G1	1270		0		1		2	
		Seal 2-5/8 x 3.876 x 3/8			77	#1951	87-5062P1	1271		2		4		8	
		Seal ¾ x 1½ x 5/16			77	#143	87-5064P1	1272		2		4		8	
		Seal			77	#2168	87-5075	1273		1		2		4	
		Bearing					5A2-82P1	1274		1		1		1	
		Ball bearing 3/8 x 7/8			153	K-6-AN	102-5118	1275		2		6		6	
		Bearing, cone			108	387	102-5170P1	1276		2		2		2	
		Bearing, cup			108	382A	102-5170P2	1278		2		2		2	
		Bearing, cone			108	A-4059	102-5177P1	1279		2		2		2	
		Cup, bearing			108	4138	102-5177P2	1280		2		2		2	
	Coupling for drive motor	Coupling			28		12-5095P2	1281		0		1		1	
		Gasket, hatch 11¼ x 9¾ O.D. 8¾ x 10 I.D. x 3/16 thick coprene			125	DC-113	87-5078P1	1282		1		2		4	
		Gasket spindle sleeve clamp ring 4½ dia., 1/32 thick			147		5A2-30P1	1283		1		2		4	
		Gasket switch box gasket 4-1/8 x 2¼ x ¾ neoprene			77	50	87-5071P1	1284		1		2		4	
		Gasket I.G. input guide gasket 5½ x 11-3/16			126	#55	87-5079P1	1285		1		2		4	
	Key for reflector bracket	Key ¼ x 3/8 x 2-1/8					5A2-67P1	1286		1		2		2	
		Woodruff key 1/8" thick by ¼ dia.				#406	105-5872P1	1287		1		2		2	
		Key SS #211 old std. woodruff			154	#211	105-5764	1288		3		6		6	
		Seal, 3-1/8 x 4.125 x ½			77	#2225	87-5063P1	1289		1		2		4	
	Coupling for synchro	1 N.T. coupling, phenolite 1-1/8 x 5/16			28		27A-15P1	1290		0		1		1	
	Coupling for synchro	D. coupling 1-1/8 x 5/8			28		5A5-134P1	1291		0		1		1	
		2 selsyn drive			45		51-5999G2	1291		0		1		1	
		2 selsyn drive			45		51-5999G1			0		0		0	
		Motor reducer assembly			120		51-5993G1	1293		0		1		1	
		Gasket, neoprene			132	BTL19-162-3	87-5067P2	1294		1		2		4	
		Gasket, "S" curve			63	7367	87-5069	1295		1		2		4	
		Gasket			132	50 Duro	5A11-169	1296		1		2		4	
		Gasket, frame			125	3C-113	5A2-71P1	1297		1		2		4	

0 No spares furnished

11-4-44

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-14AAT RESONANCE CHAMBER

PART								SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
NAVY TYPE CRP-14AAT RESONANCE CHAMBER															
		Resonance chamber	-14AAT		28	WX-4813		1401		0		0		1	
MOTORS AND SYNCHRO UNITS															
B601	Drive motor for tuning mechanism	Motor, 28 v dc, shunt wound, reversible, with speed reducer			11	44594	115-5109P1	1405		1		2		3	B601
B601A		Set (2) brush assemblies			11		103-5021	1406		5		10		20	B601A
B601B		Set (2) brush caps			11	2067	103-5022	1407		2		4		6	B601B
TERMINAL STRIPS AND MISCELLANEOUS ELECTRICAL PARTS															
E601		Terminal strip, bakelite barrier type, 4 terminals with 6-32 x ¼" binder head screws			21	4-141-¼W	47-5016P3	1415		0		0		1	E601
PLUGS AND PROBES															
P601		UHF coaxial right angle connector	-49192		2	83-1AP	79-5045	1450		1		1		2	P601
P602	Plug for resonance chamber antenna	UHF coaxial connector	-49195		2	83-1SP	79-5046	1451		1		1		2	P602
CRYSTALS															
Y601		Crystal rectifier capsule, metal part gold-plated	1N23		19	1N23	122-5002	1460		10		20		50	Y601
SPECIAL RF ASSEMBLIES															
RF601		Resonance chamber and crystal detector			28		91-5249	1465		0		1		2	RF601
MECHANICAL SPARES															
		Gasket, neoprene		RE49F203AP3	132		87-5067P1	1474		3		6		12	
		Bearing			94		102-5202	1475		1		2		3	
		Bearing			94		102-5203	1476		1		2		3	
		Gasket		RE49F197BP3			87-5051	1478		1		2		4	
		Gasket			147		5E15-81P1	1479		1		2		4	
		Gasket			125	113	5E15-80P1	1480		1		2		4	
		Gasket			125	113	5E15-79P1	1481		1		2		4	
		Key			122		5E15-109P1	1482		1		2		2	
		Captive screw			145		9-5071P3	1483		0		6		12	

0 No spares furnished

11-4-44

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-23AFD ACCESSORY CONTROL UNIT

PART								SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
NAVY TYPE CRP-23AFD ACCESSORY CONTROL UNIT															
		Accessory Control Unit	-23AFD		28	RX-1047A	A34K-X1	1501		0		0		1	
CAPACITORS															
C701	Input coupling capacitor	Capacitor, paper, .01 mfd., +20%-10%, 600 v dc wkg.	CP2-F103MK	JAN-C-5	33	PX24A	35-5089	1510		2		6		10	C701,C705,C709,C717
C702	Timing capacitor	Capacitor, silver mica, .004 mfd., ±1%, 500 v dc wkg.			32	MWSCW	35-5217	1511		1		2		2	C702,C703
C703	Timing capacitor	Same as C702								-		-		-	
C704	Sweep drive capacitor	Capacitor, paper, .1 mfd., +20%-10%, 600 v dc wkg.	CP2-F104MK	JAN-C-5	33	PX24A	35-5136	1513		1		2		3	C704
C705	Control voltage by-pass capacitor	Same as C701								-		-		-	
C706	Coupling capacitor	Capacitor, mica, .00047 mfd., ±10%, 500 v dc wkg.	CM20-471K	JAN-C-5	32	MDCW	35-5221	1515		1		1		1	C706
C707A B C	V703 cathode by-pass V703 screen grid by-pass capacitor V704B plate decoupling capacitor	Capacitor, paper, 3 x .1 mfd., ±20%, 600 v dc wkg.	-48709-A		33	2529-4	35-5092	1516		1		2		3	C707
C708	V704B bias capacitor	Capacitor, silver mica, .0004 mfd., ±5%, 500 v dc wkg.	CM20-401J	JAN-C-5	32	MDSCW	35-5211	1517		1		1		1	C708
C709	V704B cathode by-pass capacitor	Same as C701								-		-		-	
C710	Output coupling capacitor	Capacitor, paper, 0.5 mfd., +20%-10%, 600 v dc wkg.	-48704-A	RE 48A 138C	33	2529-3	35-5093	1519		1		2		3	C710
C711	V704A cathode by-pass capacitor	Capacitor, paper, .05 mfd., +20%-10%, 600 v dc wkg., 1-3/8 long, 1/2 dia.	CP2-F503MK	JAN-C-5	33	PX24A	35-5207P1	1520		1		2		3	C711
C712	Filter capacitor	Capacitor, paper, 4 mfd., ±10%, 600 v dc wkg.	CP70-F405KK	JAN-C-5	33	2538-3	35-5094	1521		2		5		8	C712,C713,C714
C713	Filter capacitor	Same as C712								-		-		-	
C714	Filter capacitor	Same as C712								-		-		-	
C715	Negative output coupling capacitor	Capacitor, mica, .0025 mfd., ±10%, 500 v dc wkg.	-481089		30	C-1225-10	35-5142	1524		1		1		1	C715
C716	Coupling capacitor	Capacitor, mica, .001 mfd., ±10%, 500 v dc wkg.	-48983-10	RE 48A 143F RE 48A 154F	32	C-1210-10	35-5036	1525		1		1		1	C716
C717	Coupling capacitor	Same as C701								-		-		-	
C718	V701A cathode voltage divider by-pass capacitor	Capacitor, paper, .02 mfd., +20%-10%, 600 v dc wkg.	CP2-F203MK		33	PX24A	35-5090	1527		1		2		3	C718
C719	Tuning capacitor	Capacitor, mica, .001 mfd., ±5%, 500 v dc wkg.			32	MWCW-1227-5	35-5139	1528		1		1		1	C719

0 No spares furnished
- For spares see reference given in "Description" column

11-4-44

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-23AFD ACCESSORY CONTROL UNIT

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		TERMINAL STRIPS AND MISCELLANEOUS ELECTR ICAL PARTS													
E701	Terminal strip for output polarity and relay coil voltage	Terminal strip, bakelite barrier type, 6 solder terminals with 6-32 x ¼" binder head screws.			21	6-141-¼W	47-5043P3	1533		0		0		1	E701
E702	Terminal strip for resonance chamber indicator assembly connections.	Terminal strip, bakelite barrier type, 4 solder terminals with 6-32 x ¼" binder head screws.			21	4-141-¼W	47-5016P3	1534		0		0		1	E702
E703	Terminal strip for voltmeter	Terminal strip, bakelite barrier type, 4 solder terminals with 6-32 x ¼" binder head screws.			21	4-141-W	47-5016P2	1535		0		0		1	E703
		Insulator, ceramic, ½" long, ¼" dia., tapped 8-32, 3/16" deep at each end.			40	1400	22-5047	1538		1		1		2	
		FUSES													
F701	Main fuse for entire unit	Fuse, 1 a, 250 v, length 2", ferrule dia. 9/16".		17-F-2	57	25002	26-5036	1543		20		40		100	F701
F702	Motor fuse for Resonance Chamber tuning	Fuse, 3 a, 250 v, length 2", ferrule dia. 9/16".		17-F-2	57	25003	26-5037	1544		10		20		50	F702
		DIAL AND PILOT LIGHTS													
I701A	Dial light, range dial 8000 yd. range	Dial light, 6 volts, 1 cp.		TS-53	15	Mazda #51	77-5001	1550		8		16		24	I701A, I702A, I704A, I705A
I701B	Socket for I701A	Socket for dial light, bayonet type base			28		81-5038P2	1551		1		1		2	I701B, I702B
I702A	Dial light, range dial 40,000 yd. range	Same as I701A								-		-		-	
I702B	Socket for I702A	Same as I701B								-		-		-	
I704A	Meter illumination	Same as I701A								-		-		-	
I704B	Socket for I704A	Socket for dial light, bayonet type base			3	#1788	81-5040			*		*		*	I704B
I705A	Meter illumination	Same as I701A								-		-		-	For spares see Tag 1676, Page 7-g
I705B	Socket for I705A	Socket for dial light, bayonet type base.			3	1787	81-5034			*		*		*	I705B
		RECEPTACLES													
J701	Accessory control input jack assy.	Jack panel assembly.			28		3K26-192	1556		1		1		2	J701
J701A		Receptacle, jack banana type.			35	152347	51-5701G3	1557		2		4		8	J701A

0 No spares furnished
- For spares see reference given in "Description" column
* For spares see reference given in "All Desig." column

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-23AFD ACCESSORY CONTROL UNIT

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		CONTACTORS AND RELAYS													
K701	Range switching relay	Relay, 4 PDT, 24 v dc coil contacts rated 15 a.			75	BO-12D35	71-5023P1	1561		1		2		3	K701
		INDUCTORS AND CHOKES													
L701	Filter choke	Reactor, 20 hy. min. ind. @ 110 ma dc and 3 v r.m.s. 60 ~ ac. Test 1200 v r.m.s. 1200¾ turns #30E wire, 300 Ω max. dc res. Wt. 15 ozs.		RE 13A 554D	28	UX-9121	92-761G1	1564		1		1		1	L701
		METERS													
M701	Meter line voltage	Voltmeter ac 300 to 600 ~ frequency, 0-150 v scale.			28	517	45-5009	1567		0		0		1	M701
		PLUGS AND PROBES													
P701	Accessory Control input plug assy.	Plug panel assembly.			28		3K27-193	1570		1		1		2	P701
P701A		Plug banana screw type and hardware.			35	152381	51-5701G4	1571		2		4		8	P701A
		RESISTORS													
R701	V701A grid resistor	Resistor, composition, 470,000 Ω ±5%, 1 watt, pigtail terminals.	-63291	RE 13A 340C	34	CM-1	80-5507	1575		1		2		3	R701
R702	Integrating resistor	Resistor, composition, 430,000 ±5%, 1 w., pigtail terminals	-63291	RE 13A 372J	115	Type SL	80-5776	1576		1		2		3	R702
R703	Timing resistor, 8000 yd. range	Resistor, precision, wirewound, 50,000 Ω ±2%, 1 watt.		RE 13A 372J	115	Type SL	80-5865	1577		1		3		5	R703
R704	Timing resistor, 40,000 yd. range	Resistor, precision wirewound, 250,000Ω -1%, +2%, 1 watt.	-63703-5	RE 13A 372J	115	WW14	80-6051	1578		1		2		3	R704
R705	V701B cathode resistor	Resistor, composition, 62,000 Ω ±5%, 1 watt, pigtail terminals.	-63291	RE 13A 340C	34	CM-1	80-5458	1579		1		3		5	R705, R706
R706	V701B cathode resistor	Same as R705	-63291	RE 13A 340C						-		-		-	
R707	Control voltage potentiometer	Resistor, potentiometer, wirewound, 20,000 Ω ±10%, 6 watts, linear taper, shaft 19/32" long.		RE 13A 492C	83	314A	40-5040P1			*		*		*	R707 For spares see Tag 1684, Page 7-g
R708	Control voltage filter resistor	Resistor, composition, 22,000 Ω ±10%, ¼ watt, pigtail terminals.	-63360	RE 13A 340C	34	MB-¼	80-5425	1582		1		2		3	R708
R709	Part of control voltage divider	Resistor, wirewound, 1800 Ω ±5%, .2 watts, pigtail terminals.	-63705-5	RE 13A 372J	20	BW-2	80-5876	1583		2		4		8	R709, R710, R711

0 No spares furnished
- For spares see reference given in "Description" column
* For spares see reference given in "All Desig." column

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-23AFD ACCESSORY CONTROL UNIT

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP.		TENDER		STOCK		ALL SYMBOL DESIGNATIONS INVOLVED
									BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	
		RESISTORS (Cont'd.)													
R710	Part of control voltage divider	Same as R709								-		-		-	
R711	Part of control voltage divider	Same as R709								-		-		-	
R712	Part of 8000 yd. control voltage divider	Resistor, wirewound, 620 Ω ±5%, 1 watt, pigtail terminals.	-63703-5	RE 13A 372J	20	BW-1	80-5407	1586		1		3		5	R712, R719
R713	8000 yd. high set	Resistor, potentiometer, wirewound, 5000 Ω ±10%, 3 watts, linear taper, special shaft 11/16" long.		RE 13A 492C	8	P58W	40-5039P1	1587		2		6		10	R713, R723
R714	40,000 yd. high set	Resistor, potentiometer, wirewound, 5000 Ω ±10%, 3 watts, linear taper, special shaft 1-7/8" long.		RE 13A 492C	8	P58W	40-5039P3	1588		2		6		10	R714, R722
R715	Part of control voltage divider	Resistor, wirewound, 5000 Ω ±5%, 1 watt, pigtail terminals.	-63703-5	RE 13A 372J	20	BW-1	80-5287	1589		3		9		18	R715, R716, R717, R718, R737, R738
R716	Part of control voltage divider	Same as R715	-63703-5							-		-		-	
R717	Part of control voltage divider	Same as R715	-63703-5							-		-		-	
R718	Part of control voltage divider	Same as R715	-63703-5							-		-		-	
R719	Part of 40,000 yd. control voltage divider	Same as R712	-63703-5							-		-		-	
R720	Part of 8000 yd. control voltage divider	Resistor, wirewound, 5000 Ω ±5%, 2 watts, pigtail terminals.	-63705-5	RE 13A 372J	20	BW-2	80-5337	1594		1		2		3	R720
R721	Part of 40,000 yd. control voltage divider	Resistor, wirewound, 1500 Ω ±5%, 1 watt, pigtail terminals.	-63703-5	RE 13A 372J	20	BW-1	80-5288	1595		1		2		3	R721
R722	8000 yd. low set	Same as R714								-		-		-	
R723	40,000 yd. low set	Same as R713								-		-		-	
R724	V703 grid resistor	Resistor, composition, 100,000 Ω ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 340C	34	MB-½	80-5235	1597		1		3		5	R724, R733
R725	V703 cathode resistor	Resistor, composition, 150 Ω ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 340C	34	MB-½	80-5351	1598		1		2		3	R725
R726	V703 screen grid resistor	Resistor, composition, 30,000 Ω ±10%, 1 watt, pigtail terminals.	-63288	RE 13A 340C	34	CM-1	80-5228	1599		1		2		3	R726
R727	V704A cathode resistor	Resistor, composition, 2000 Ω ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 340C	34	MB-½	80-5211	1600		1		2		3	R727
R728	V704B bias resistor	Resistor, composition, 330,000 Ω ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 340C	34	MB-½	80-5438	1601		1		2		3	R728
R729	V704B cathode resistor	Resistor, composition, 7500 Ω ±5%, ½ watt, pigtail terminals.	-63355	RE 13A 340C	34	MB-½	80-5424	1602		1		2		3	R729
R730	V704B cathode resistor for positive output	Resistor, composition, 18 Ω ±5%, ½ watt, pigtail terminals.	-63355	RE 13A 340C	34	MB-½	80-5602	1603		1		3		5	R730, R731
R731	V704B cathode resistor for positive output	Same as R730	-63355							-		-		-	
R732	V704B cathode voltage divider resistor	Resistor, composition, 100,000 Ω ±5%, 1 watt, pigtail terminals.	-63291	RE 13A 340C	34	CM-1	80-5301	1605		1		2		3	R732

- For spares see reference given in "Description" column

11-4-44

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-23AFD ACCESSORY CONTROL UNIT

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP.		TENDER		STOCK		ALL SYMBOL DESIGNATIONS INVOLVED
									BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	
		RESISTORS (Cont'd.)													
R733	V704B plate decoupling resistor	Same as R724	-63360							-		-		-	
R734	Marker output control	Resistor, dual potentiometer, each section 200 Ω ±2 watts, linear taper, special shaft.		RE 13A 492C	20	Type W	40-5115P1	1607		1		3		5	R734
R735	Negative output attenuating resistor	Resistor, composition, 2400 Ω ±5%, ½ watt, pigtail terminals.	-63355	RE 13A 340C	34	MB-½	80-5521	1608		1		2		3	R735
R736	Part of V701A cathode voltage divider	Resistor, precision, wirewound, 80,000 Ω ±2%, 1 watt.		RE 13A 372J	115	Type SL	80-6027	1609		1		3		5	R736
R737	Part of V701A cathode voltage divider	Same as R715	-63703-5							-		-		-	
R738	Part of V701A cathode voltage divider	Same as R715	-63703-5							-		-		-	
R744	Dial light intensity control	Resistor, potentiometer, wirewound, 50Ω ±10%, 25 watts, linear taper, spec. shaft.		RE 13A 492C	8	PW-25-50	40-5048	1616		1		3		5	R744
R745	Dropping resistor for V705 and V706	Resistor, wirewound, 2675 Ω ±5%, Style D, Grade 1, Class II, 12 watts.	-632071-E	RE 13A 372J			80-6036	1617		1		2		3	R745
R746	Equalizing resistor for V705 and V706	Resistor, composition, 100,000 Ω ±5%, ½ watt, pigtail terminals.	-63355	RE 13A 340C	34	MB-½	80-5295	1618		1		3		5	R746, R747
R747	Equalizing resistor for V705 and V706	Same as R746	-63355							-		-		-	
R748	Bleeder resistor	Resistor, composition, 270,000 Ω ±10%, 1 watt, pigtail terminals.	-63288	RE 13A 340C			80-5503	1620		1		2		3	R748
R749	Dropping resistor for 24 v relay (when used on 115 v.)	Resistor, wirewound, 800 Ω ±5%, Style D, Grade 1, Class II.	-63074-E	RE 13A 372J			80-5298	1621		1		2		3	R749
R761	Grid resistor	Resistor, composition, 10,000 Ω ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 340C	34	MB-½	80-5218	1626		1		2		3	R761
R762	Cathode resistor	Resistor, composition, 100 Ω ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 340C	34	MB-½	80-5204	1627		1		3		5	R762, R764
R763	Grid resistor	Resistor, composition, 500,000 Ω ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 340C	34	MB-½	80-5243	1628		1		2		3	R763
R764	Cathode resistor	Same as R762	-63360							-		-		-	
R765	Grid resistor	Resistor, composition, 3 MΩ ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 340C	34	MB-½	80-5297	1630		1		2		3	R765
R766	Cathode resistor	Resistor, composition, 50 Ω ±10%, ½ watt, pigtail terminals.	-63360	RE 13A 340C	34	MB-½	80-5260	1631		1		2		3	R766
R767	Plate resistor	Resistor, composition, 200,000 Ω ±10%, 1 watt, pigtail terminals.	-63288	RE 13A 340C	34	CM-1	80-5257	1632		2		6		10	R767, R768, R769, R770
R768	Plate resistor	Same as R767	-63288							-		-		-	
R769	Plate resistor	Same as R767	-63288							-		-		-	
R770	Plate resistor	Same as R767	-63288							-		-		-	

- For spares see reference given in "Description" column

11-4-44

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-23AFD ACCESSORY CONTROL UNIT

PART								SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
SWITCHES, INTERLOCKS AND THERMOSTATS															
S701	Voltmeter switching push button	Switch, button type, DPDT.			4	3599C	28-5121	1640		1		1		1	S701
S703	IFF switch	Switch, lever type 4 PDT, 3 position, center open.			36		28-5079P2	1642		1		1		1	S703
S704	Relative bearing on-off switch	Switch, toggle type SPST current rated for 6 a, 230v.			4	#80607	28-5086	1643		1		1		1	S704, S706
S705	Motor control and reversing switch	Switch, lever type DPDT.			36		28-5071P2	1644		1		1		1	S705
S706	A.F.C. relay switch	Same as S704								-		-		-	
TRANSFORMERS															
T701	Plate supply voltage transformer	Transformer, Plate: Pri. 115/60/1φ Wind. / No. Turns / Wire Size / DC Res. / Volts / Amps / Test V r.m.s. Pri. 872 22E 4.40 115 1.0 1780 Sec. #1 4420 31E .320 690 .11 1780 Sec. #2 32 17E .110 5 3.0 1780 Sec. #3 40 17E .165 6.3 3.0 1780 Sec. #4 40 22E .65 6.3 0.7 1780 Pri. rated, 115 va (approx.) Elec. shield Sec. #1 CT.		RE 13A 554D	28	UX-9120	92-760G1	1647		1		2		3	T701
T703	Input pulse transformer	Transformer: Wind. / No. Turns / Wire Size / DC Res. / Volts / Amps / Test V r.m.s. Pri. 66 2x27E .329 5 - 500MΩ Sec. 480 38E 60 41 - 500MΩ			28	UX-7896	92-695G1	1649		1		2		3	T703
T704	Coupling transformer	Transformer: Wind. / No. Turns / Wire Size / DC Res. A 50 36E 1.75 B 50 36E 1.9 C 50 36E 2.05			28	UX-7307	92-5145	1650		2		4		6	T704, R705
T705	Coupling and blocking oscillator transformer	Same as T704								-		-		-	
*** VACUUM AND GASEOUS DISCHARGE TUBES**															
V701	Clamper and cathode follower	Twin triode, low Mu amplifier.	6SN7-GT		29	6SN7-GT	90-5051			10		15		0	V701, V702, V704, V709, V710
V702	Isolating diode and pick-off diode	Same as V701	6SN7-GT							-		-		-	
V703	Amplifier	Television, amp. pentode.	6AC7		29	6AC7/1852	90-5072			2		3		0	V703

0 No spares furnished
- For spares see reference given in "Description" column
* Packed in wooden boxes - See Packing List

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-23AFD ACCESSORY CONTROL UNIT

PART								SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
*** VACUUM AND GASEOUS DISCHARGE TUBES (Cont'd.)**															
V704	Amplifier and blocking oscillator	Same as V701	6SN7-GT							-		-		-	
V705	Voltage regulator "B" supply	Voltage regulator	-38205		29	(VR-105-30)	90-5058			4		6		0	V705, V706
V706	Voltage regulator "B" supply	Same as V705	-38205							-		-		-	
V707	Rectifier	Full wave rectifier.	5U4-G		29	5U4-G	90-5056			2		3		0	V707
V709	Pulse amplifier	Same as V701	6SN7-GT							-		-		-	
V710	Pulse integrator	Same as V701	6SN7-GT							-		-		-	
SPECIAL CABLES															
W701		Coax cable assembly.			28		5E-43	1652		1		1		2	W701
SOCKETS AND FUSE HOLDERS															
X701	Socket for V701	Vacuum tube socket, 8 contacts, ceramic wafer, silvered contacts and mtg.			2	RSS-8M	82-5012P3	1654		5		5		9	X701, X702, X703, X704, X705, X706, X707, X708, X709
X702	Socket for V702	Same as X701								-		-		-	
X703	Socket for V703	Same as X701								-		-		-	
X704	Socket for V704	Same as X701								-		-		-	
X705	Socket for V705	Same as X701								-		-		-	
X706	Socket for V706	Same as X701								-		-		-	
X707	Socket for V707	Same as X701								-		-		-	
X708	Socket for T704	Same as X701								-		-		-	
X709	Socket for T705	Same as X701								-		-		-	
X715	Socket for V709	Vacuum tube socket, 8 contacts, ceramic, wafer, silvered contacts.			2	SS-8M	82-5012P2	1659		1		1		2	X715, X716
X716	Socket for V710	Same as X715								-		-		-	
MECHANICAL SPARES															
	For dial light assembly on meter M701	Spacer (cork) 7/16" x 6-1/4" x 1/16" thick.			28		3K1-134P1	1672		1		2		4	
	For panel mounting	Plug, pilot light			28		3K1-21P1	1673		1		1		2	
	Window for meter M701	Window, meter			28		3K1-27P1	1674		1		2		3	
	Range window	Window, safety glass, 1-11/32" x 1-27/32" x 1/8" thick.			28		3K1-30P1	1675		1		2		3	

0 No spares furnished
- For spares see reference given in "Description" column
* Packed in wooden boxes - See Packing List

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-23AFD ACCESSORY CONTROL UNIT

PART								SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		MECHANICAL SPARES (Cont'd.)													
	For meter illumination	Meter light assembly			28		3K23-175	1676		0		1		1	
	For mounting meter M701	Block, meter			28		3K1-26P1	1677		0		1		1	
	For driving range dial	Driver, dial, neoprene, 1-1/8" x 3/8" x 1/16".			28		3K6-68P1	1678		0		1		2	
		Cap, push button			28		3K1-22P1	1679		0		2		4	
	For range window	Vane holder assembly			28		3K1-35	1680		0		1		2	
	For driving range dial	Dial drive gear assembly			28		3K6-7	1681		0		1		2	
	For dial assembly	Rubber stop, neoprene			28		3K7-74P1	1682		0		1		2	
	For chassis mounting	Dial support assembly			28		3K5-6	1684		1		3		5	
	Gasket for pilot light	Gasket, neoprene, 3/8" I.D. x 19/32"O.D. x 3/32" thick.			28		3K1-20P1	1686		1		2		4	
	Gasket for meter M701	Gasket			28		3K1-28P1	1687		1		2		4	
	Gasket for range window	Gasket, neoprene, 1-5/8" x 2-1/8".			28		3K1-37P1	1688		1		2		4	
	Gasket for front panel	Gasket, soft molded rubber, 7-3/8" x 7-15/16".			28		3K1-38P1	1689		1		2		4	
	Gasket for meter window	Gasket, neoprene			28		3K1-50P1	1690		1		2		4	
	Gasket for co-ax terminal box	Gasket, 2" x 2" x 1/16" thick with 1-3/16" hole, Garlock #660.			28		3K3-81P1	1691		1		2		4	
	Gasket for cable pipe	Gasket, 1" I.D. x 1-3/16" O.D., Tyre Rubber Co., Compound #7220.			28		3K3-85P1	1692		4		8		16	
	Sleeve for cable	Grommet, 1/2" x 13/16" O.D. x 9/32" thick.			28		3K2-117P1	1693		5		10		20	
	Sleeve for cable	Grommet, 3/8" I.D. x 11/16" O.D. x 9/32" thick.			28		3K2-118P1	1694		3		6		12	
	Range crank waterproofing assembly	Mounting bushing assembly			28		3K29-195	1696		0		1		2	
	For holding unit into case	Captive screw			28		3C7-382P2	1698		0		6		12	
	Cover for I.F.F. switch	Rubber gauntlet			28		3C7-220P1	1701		1		2		4	
	For lever bar assembly	Lever bar handle			28		3C5-260P2	1702		0		1		2	
	Guide for sliding unit into case	Slider foot			28		3C6-124P1	1705		0		1		4	
	For maintaining air pressure in unit	Air valve assembly			28		3C18-194	1707		0		1		2	
	For potentiometers	Knob (large) assembly			28		3C23-103	1708		1		2		3	
	For potentiometers	Knob (small) assembly			28		3K1-191	1709		1		2		3	
	For ACF & SHF switches	Glove, toggle switch, neoprene #940			28		3K1-33P1	1710		2		4		8	
	For driving gear support assembly	Hand crank assembly			28		3C22-208	1711		0		1		2	
	Gasket for terminal box casting	Gasket, neoprene, .080 thick			28		3C5-144P1	1712		1		2		4	
	Gasket for terminal box cover	Gasket, neoprene, 1/16" thick			28		3C5-145P1	1713		1		2		4	

0 No spares furnished

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-23AFD ACCESSORY CONTROL UNIT

PART								SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		MECHANICAL SPARES (Cont'd.)													
	Gasket for potentiometers	Gasket, neoprene 39/64" I.D. x 51/64" O.D.			28		3C7-354P1	1714		9		18		36	
	Plug for shipping purposes	Plug, threaded			28		3C5-186P2	1716		0		1		2	
	Gasket for crank body	Gasket, 39/64" I.D. x 7/81 O.D. x 1/32" thick, Garlock #660.			28		3K1-19P1	1717		1		2		4	
	Gasket for range window	Gasket, 2-3/32 x 2-19/32 x 1/16" thick, Garlock #660.			28		3K1-49P1	1718		1		2		4	
		Button			28		28-5087	1719		0		1		2	
	Handle for tune switch	Handle, motor switch			28		3C7-218P1	1726		0		1		1	
		Tube lock with locating tab			93	926-C-13	88-5078P4	1729		0		2		4	
		Tube lock with locating tab			93	926-B-16	88-5078P5	1730		0		3		6	
		Tube lock with locating tab			93	926-A-14	88-5078P6	1731		0		2		4	
		Tube lock for metal tube			28		88-5122	1732		0		1		2	
	For potentiometers	Potentiometer waterproofing assembly			28		3K30-196	1737		0		1		2	
		Spring			140		5E10-32P1	1740		3		6		15	
		Spring			146		88-5035P1	1741		2		4		10	
		Gasket			141		105-5657P1	1742		2		4		8	
		Grommet			141	#1119	4-5024	1743		1		2		4	
		Gasket			77		3C7-239P1	1744		1		2		4	
		Switch - waterproofing			149		3K28-194	1745		0		1		2	
		NAVY TYPE CRP-10252 MOUNTING RACK													
		Mounting rack	-10252		28	WX-5611		1755		0		0		1	

0 No spares furnished

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
R.F. FILTER UNIT RX-1254
FOR USE WITH SO-4 RADAR EQUIPMENT

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
NABY TYPE CRP-53198 R.F. FILTER ASSEMBLY															
		R.F. filter assembly	-53198		28	RX-1254		4101		0		0		1	
R.F. FILTER UNIT ASSEMBLIES															
Z801	Main line filter	Radio interference filter 20 amps, 115 v 60~ ac	-53199		32	EN-106	92-5137	4105		1		2		3	Z801
Z802	Antenna drive motor filter	Radio interference filter 3 amps, 115 v ac/dc	-53200		32	EN-107	92-5138	4106		1		2		3	Z802
MECHANICAL PARTS															
		Gasket					9R-8P1	4116		1		2		4	

0 No spares furnished

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
JUNCTION BOX RX-1304 FOR USE WITH SO-4 RADAR EQUIPMENT

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
NAVY TYPE CRP-62152 JUNCTION BOX															
		Junction Box	-62152		28	RX-1304		2800		0		0		1	
CAPACITORS															
C1301	To elminate arcing at contacts K1301 and K1302	Capacitor, paper, oil-filled, 4 mfd., ±10%, 1000 v wkg.	-481050-10		9	TJU-10040	35-5063	2805		1		2		3	C1301
C1302	To elminate arcing at contacts K1301 and K1302	Capacitor, paper, oil-filled, 2 mfd., ±10%, 1000 v wkg.	-481049-10		9	TJU-10020	35-5080	2806		1		3		5	C1302, C1303
C1303	To elminate arcing at contacts K1301 and K1302	Same as C1302	-481049-10							-		-		-	
TERMINAL STRIPS AND MISCELLANEOUS ELECTRICAL PARTS															
E1310	Junction to terminate cables	Terminal strip, barrier type, 8 solder terminals with 6-32 x ¼" binder head screws.			21	8-141-¾W	47-5021P3	2815		0		0		2	E1310, E1315
E1315	Junction to terminate cables	Same as E1310								-		-		-	
E1318	Junction to terminate cables	Terminal strip, barrier type, 12 solder terminals with 6-32 x ¼" binder head screws.			21	12-141-¾W	47-5048P3	2823		0		0		3	E1318, E1322, E1323
E1321	Junction to terminate cables	Terminal strip, barrier type, 4 solder terminals with 8-32 x 5/16" binder head screws.			21	4-142-¾W	47-5017P3	2826		0		0		1	E1321
E1322	Junction to terminate cables	Same as E1318								-		-		-	
E1323	Junction to terminate cables	Same as E1318								-		-		-	
CONTACTORS AND RELAYS															
K1301	Antenna armature current control	Relay, 4PDT, 24 v dc coil, contacts rated @ 15 a.				BO12D35	71-5023	2848		1		3		5	K1301, K1302
K1302	Antenna armature current control	Same as K1301								-		-		-	
RESISTORS															
R1301	Resistor to limit armature current	Resistor, fixed resistance strip, 5 Ω, 7 a., 250 w., monel sheath with mounting feet.		RE 13A 372J	90	Type 5 S-920	80-5326	2860		2		9		15	R1301, R1302, R1303
R1302	Resistor to limit armature current	Same as R1301								-		-		-	
R1303	Resistor to limit armature current	Same as R1301								-		-		-	

0 No spares furnished
- For spares see reference given in "Description" column

(4)

TABLE II

PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION

JUNCTION BOX RX-1304 FOR USE WITH SO-4 RADAR EQUIPMENT

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		RESISTORS (Cont'd)													
R1304	Relay dropping resistor	Resistor, wirewound, 800 Ω, ±5%, Style E, Grade 1, Class I	-63984-F	RE 13A 372J	35		80-5267	2863		1		3		5	R1304, R1305
R1305	Relay dropping resistor	Same as R1304	-63984-F							-		-		-	
R1306	Current-limiting resistor for antenna motor field	Resistor, 160 Ω ±5%, Style E, Grade 2, Class I	-63978-D				80-6031	2865		1		2		3	R1306
		MECHANICAL SPARES													
	For resistor leads	Grommet			141		4-5024	2875		1		2		4	
	To waterproof case	Gasket			126		4E1-118	2876		1		2		4	
	To waterproof flanges	Gasket for junction box			76		4E1-124P2	2878		1		2		4	
	To waterproof flanges	Gasket			76		4E1-124P1	2879		3		6		12	
	To lock cover	Captive wing bolts			166		9-5118P3	2880		0		0		12	
	To lock cover with above 9-5118P3	Captive nut			165		4E1-65P1	2881		0		0		12	
	To lock cover	Spring			164		4E1-135P1	2882		16		32		80	
	To fasten chassis	Captive screw			145		9-5071P1	2883		0		3		6	
	To fasten panel and chassis	Retaining ring			163		105-5539P1	2884		2		4		6	
	To hold up captive nut	Spring captive nut			165		4E1-63P1	2885		18		36		90	
	To protect equip. from moist.	Protek plug			51	#1178	79-5033P1	2886		10		60		100	
	To waterproof air valve assembly	Gasket			76		22N11-84	2887		1		2		4	

0 No spares furnished
- For spares see reference given in "Description" column

(4)

TABLE II

PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION

FOR MOTOR-ALTERNATOR AND CONTROL UNITS

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		MOTOR-ALTERNATOR AND CONTROL UNITS													
		Motor-Alternator and Control Units per Raytheon Spec. S-115-5138 consisting of the following:			42		115-5138	4201		0		0		0	
	System Power Generator	Motor-Alternator, 115 v dc to 115 v 60~ 1Φ. Power output 2kva at 90% P.F., 3600 r.p.m.	-211241		42	E10100-03-600	115-5139	4203		0		0	2	1	
	Controller for Motor-Alternator	Magnetic Controller with compensated overload relay, overspeed and low voltage protection, voltage and speed regulators for control of Motor Alternator	-211242		42	E9945-01-600	91-5139	4205		0		0	2	1	
	Start-Stop Switch	Push Button Station 4 isolated circuits 2 n.o. and 2 n.c. contacts silver plated, rating 250 v.	-24291		42	E9960-03-601	28-5122	4207		0	2	2	2	2	
	***	Set of Equipment Spares for Motor-Alternator and Control Unit; consisting of all items on Pages 20 to 20-e furnished in quantities as shown in Equipment Spares column			42	E1187-01-600	115-5140	4208	1	1		0		0	
	***	Set of Tender Spares for Motor-Alternator and Control Unit; consisting of all items on Pages 20 to 20-e furnished in quantities as shown in Tender Spares column			42	E11460-01-600	115-5141	4209		0	1/2	1		0	
	***	Set of Stock Spares for Motor-Alternator and Control Unit- consisting of all items on Pages 20 to 20-e furnished in quantities as shown in Stock Spares column			42	E11461-01-660	115-5142	4211		0		0	1	1	
		MOTORS													
B2009	Torque Unit for Z2002 speed regulator	Torque Motor-Complete			42	E10514-01-500	115-5149	4218	1	1	1	4	1	6	B2009, B2010
B2010	Torque Unit for Z2001 voltage regulator	Same as B2009								-		-		-	
B2101		Main armature assembly with bearings mounted			42	E10102-02-500	115-5145	4225		1	2	1	1	2	B2101
B2102		Set of 2 dc motor field coils			42	E4227-07-500	115-5146	4226		1	2	2	1	4	B2102
B2103		DC motor interpole coil			42	E7811-02-500	115-5147	4228		1	1	2	1	4	B2103
B2104		Set of 2 generator field coils			42	E10108-01-500	115-5148	4230		1	1	2	1	4	B2104
B2105		Set of 2 generator brush holder assemblies			42	E11235-01-500	103-5122	4232	1	1	1	4	1	6	B2105
B2106		Set of 2 DC motor brush holder assemblies			42	E10106-02-500	103-5123	4234	1	1	1	4	1	6	B2106

0 No spares furnished
- For spares see reference given in "Description" column
*** These sets represent summaries and are not in addition to the individual items listed
** These box numbers refer to wooden packing cases

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR MOTOR-ALTERNATOR AND CONTROL UNITS

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP.		TENDER		STOCK		ALL SYMBOL DESIGNATIONS INVOLVED
									BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	
		MOTORS (Cont'd)													
B2107		Set of 2 generator brushes with springs			42	E11237-01-500	103-5124	4236	1	5	1	10	** 1	20	B2107
B2108		Set of 4 DC motor brushes with springs			42	E11236-01-500	103-5125	4238	1	5	1	10	1	20	B2108
B2109		Bearing spring washer				E6680-05-001	36-5185	4240		0	1	1	1	1	B2109
		CAPACITORS													
C2001	Phase shift capacitor for B2010 torque motor	Capacitor, paper, oil-filled 10 mfd., ±10%, 330 v ac wkg.	-482363		1	21-F75G3	35-5274	4250	1	1	1	2	1	3	C2001
C2002	Phase shifting capacitor for B2009 torque motor	Capacitor, paper, oil-filled, 5 mfd., ±10%, 660 v ac wkg.	-482364		1	21-F100G3	35-5275	4252	1	1	1	2	1	3	C2002
		TERMINAL STRIPS AND MISCELLANEOUS ELECTRICAL PARTS													
E2001	Terminal strip for Z2003	Terminal strip bakelite barrier type, 8 screw terminals with 5/16 x 8-32 BBD screws			21	8-142	47-5022P1	4260		0		0	1	1	E2001
		FUSES													
F2001	Control circuit fuse, positive side	Fuse, 10 a, 250 v length 2", dia. 9/16 ferrule			118	1110	26-5068	4270	1	20	1	40	1	100	F2001, F2002
F2002	Control circuit fuse, negative side	Same as F2001								-		-		-	
		CONTACTS AND RELAYS													
K2001	Main contactor positive side	Contactor, 3 PST, 2 n.o. and 1 n.c. contacts								0		0		0	
K2001A		Operating coil			42	CR259-01-500	71-5051	4280	1	1	1	3	1	3	K2001A, K2002A
K2001B		Set of 4 main contacts			42	E433-04-500	71-5052	4282	1	1	1	2	1	2	K2001B, K2002B
K2001C		Set of 2 operating springs			42	E154765-05-001	88-5101	4284	1	1	1	1	1	1	K2001C, K2002C
K2001D		Main contact spring			42	E158378-09-003	88-5099	4286	1	1	1	1	1	1	K2001D, K2002D
K2001E	N.o. auxiliary holding contacts for K2001									0		0		0	
K2001EA		Set of 5 stationary contacts			42	E7679-02-001	71-5054	4290	1	1	1	2	1	2	K2001EA, K2002EA, K2001FA, K2002FA, K2002GA
K2001FB		Set of 6 movable contacts			42	E10672-01-500	71-5055	4294	1	1	1	2	1	2	K2001EB, K2002EB, K2001FB, K2002FB, K2002GB, K2004CA
K2001EC		Auxiliary contact spring			42	E155708-01-001	88-5100	4296	1	1	1	1	1	1	K2001EC
K2001F	N.c. auxiliary contacts on K2001 for deenergizing K2003									0		0		0	

0 No spares furnished
- For spares see reference given in "Description" column
** These box numbers refer to wooden packing cases

Revised 10-3-44

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR MOTOR-ALTERNATOR AND CONTROL UNITS

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP.		TENDER		STOCK		ALL SYMBOL DESIGNATIONS INVOLVED
									BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	
		CONTACTS AND RELAYS (Cont'd)													
K2001FA		Same as K2001EA								-		-	**	-	
K2001FB		Same as K2001EB								-		-		-	
K2001FC		Set of 5 auxiliary contact springs			42	E154886-19-012	88-5106	4308	1	1	1	1	1	1	K2001FC, K2002EC, K2002FC, K2002GC, K2004CC
K2002	Main contactor negative side	Contactor 4PST 3 n.o. and 1 n.c. contacts								0		0		0	
K2002A		Same as K2001A								-		-		-	
K2002B		Same as K2001B								-		-		-	
K2002C		Same as K2001C								-		-		-	
K2002D		Same as K2001D								-		-		-	
K2002E	N.o. auxiliary (emergency run) contacts for K2002									0		0		0	
K2002EA		Same as K2001EA								-		-		-	
K2002EB		Same as K2001EB								-		-		-	
K2002EC		Same as K2001FC								-		-		-	
K2002F	N.c. auxiliary (speed regulator by-pass) contacts for K2002									0		0		0	
K2002FA		Same as K2001EA								-		-		-	
K2002FB		Same as K2001EB								-		-		-	
K2002FC		Same as K2001FC								-		-		-	
K2002G	N.o. auxiliary (shunt field circuit) contacts for K2002									0		0		0	
K2002GA		Same as K2001EA								-		-		-	
K2002GB		Same as K2001EB								-		-		-	
K2002GC		Same as K2001FC								-		-		-	
K2003	Accelerating contactor	Contactor, 4PST, 3 aux. n.o. and 1 main n.c. contacts								0		0		0	
K2003A		Operating coil			42	CR239-03-500	71-5056	4336	1	1	1	3	1	3	K2003A
K2003B	Main contacts for K2003									0		0		0	
K2003BA		Stationary contact			42	E9028-02-501	71-5057	4340	1	1	1	2	1	2	K2003BA
K2003BB		Movable contact			42	E9027-02-501	71-5058	4344	1	1	1	2	1	2	K2003BB
K2003BD		Main contact spring			42	E563-09-003	88-5103	4346	1	1	1	1	1	1	K2003BD
K2003C		Operating spring			42	E8966-01-001	88-5105	4348	1	1	1	1	1	1	K2003C
K2003D	N.o. auxiliary (starting) contacts for K2003									0		0		0	
K2003DA		Set of 2 stationary contacts			42	E9939-02-500	71-5072	4350	1	1	1	2	1	2	K2003DA
K2003DB		Set of 3 movable contacts			42	E8010-04-502	71-5060	4352	1	1	1	2	1	2	K2003DB, K2003EB, K2003FB

0 No spares furnished
- For spares see reference given in "Description" column
** These box numbers refer to wooden packing cases

Revised 10-3-44

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR MOTOR-ALTERNATOR AND CONTROL UNITS

PART								SPARES						
								EQUIP.		TENDER		STOCK		
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		CONTACTS AND RELAYS (Cont'd)													
K2003DC		Set of 3 auxiliary contact springs			42	E8014-01-002	88-5104	4354	1	1	1	1	** 1	1	K2003DC, K2003EC, K2003FC
K2003E	N.o. auxiliary contacts (C2002 by-pass) for K2003									0		0		0	
K2003EA		Set of 4 stationary contacts			42	E8020-01-500	71-5059	4358	1	1	1	2	1	2	K2003EA, K2003FA
K2003EB		Same as K2003DB								-		-		-	
K2003EC		Same as K2003DC								-		-		-	
K2003F	N.o. auxiliary contacts (speed regulator by-pass) for K2003									0		0		0	
K2003FA		Same as K2003EA								-		-		-	
K2003FB		Same as K2003DB								-		-		-	
K2003FC		Same as K2003DC								-		-		-	
K2004	Field failure relay	Relay, single pole, single throw, n.c.								0		0		0	
K2004A		Operating coil			42	CR246-01-500	92-5133	4366	1	1	1	3	1	3	K2004A
K2004B		Operating spring			42	E154170-02-001	88-5107	4368	1	1	1	1	1	1	K2004B
K2004C	Contacts for K2004, normally closed									0		0		0	
K2004CA	Stationary Contact	Same as K2001EB								-		-		-	
K2004CB		Movable contact			42	E10923-01-001	71-5063	4374	1	1	1	2	1	2	K2004CB
K2004CC		Same as K2001FC								-		-		-	
K2005	Overload relay	Thermal overload relay single pole, contacts normally closed, temperature compensated			42	E10535-01-501	71-5064	4378	1	1	1	2	1	3	K2005
		INDUCTORS AND CHOKES													
L2001	Resonating reactor	Reactor, variable air-gap iron core type max. inductance 1.39H			42	E10524-02-500	92-5134	4384		1	2	2	1	3	L2001
		RESISTORS													
R2001	Coil current limiting resistor	Resistor, wirewound, 100 Ω ±5%, Style C Grade 2, Class 1 ferrule	63791-D	RE 13A 372J	42	E8766-01-003	80-6035	4394	1	1	1	2	1	3	R2001
R2002	Starting resistor	Resistor, helical wound steel 0.95 Ω ±10%, 400 w		RE 13A 372J	42	E10949-01-501	80-5888	4396	1	1	1	3	1	3	R2002
R2003	Field discharge resistor	Resistor, wirewound 250 Ω ±5%, Style A, Grade 2, Class 1 ferrule	63192-D	RE 13A 372J	42	E8766-01-004	80-5889	4398	1	1	1	2	1	3	R2003
R2004	Torque motor limiting resistor	Resistor, wirewound 160 Ω ±5%, Style B, Grade 2, Class 1 ferrule	63902-D	RE 13A 372J	42	E8766-01-001	80-5891	4400	1	1	1	2	1	3	R2004
R2005	Voltage adjusting rheostat	Resistor, potentiometer, wirewound 50 Ω ±10%, 50 w			42	E8796-01-001	40-5065P1	4402	1	1	1	3	1	5	R2005

0 No spares furnished
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** These box numbers refer to wooden packing cases

Revised 10-3-44

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR MOTOR-ALTERNATOR AND CONTROL UNITS

PART								SPARES						
								EQUIP.		TENDER		STOCK		
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		RESISTORS (Cont'd)													
R2006	Torque motor limiting resistor	Resistor wirewound 90 w 180 Ω ±5%, Style B, Grade 2, Class 1 ferrule	-632294-D		42	E8766-01-002	80-5893	4404	1	1	1	2	** 1	3	R2006, R2007
R2007	Torque motor limiting resistor	Same as R2006								-		-		-	
		ASSEMBLIES													
Z2001	Voltage regulator	Voltage regulator assembly, voltage sensitive torque motor operated, rocking-contact type			42	E10513-02-600	91-5144	4422		0	2	1	1	2	Z2001
Z2001A		Commutator assembly with step resistor for voltage regulator			42	E10532-01-500	51-5915	4424	1	1	1	2	1	3	Z2001A
Z2001B		Set of 2 sectors with shunt leads			42	E8774-01-500	51-5914	4426	1	1	1	2	1	3	Z2001B, Z2002B
Z2001C		Set of 2 sector springs			42	E10518-01-001	88-5108	4428	1	1	1	1	1	1	Z2001C, Z2002C
Z2001D		Set of 2 sector jewel and spring assemblies			42	ER15038-03-503	88-5111	4430	1	1	1	1	1	1	Z2001D, Z2002D
Z2001E		Set of 2 recall spring			42	ER15003-06-005	88-5109	4432	1	1	1	1	1	1	Z2001E, Z2002E
Z2001F		Stop spring			42	E5854-03-002	88-5110	4434	1	1	1	1	1	1	Z2001F, Z2002F
Z2001G		Main spring			42	E10534-01-001	88-5112	4436	1	1	1	1	1	1	Z2001G
Z2001H		Auxiliary spring			42	E8765-01-001	88-5113	4438	1	1	1	1	1	1	Z2001H
Z2002	Speed regulator for 211241 Motor-Alternator	Frequency-sensitive torque motor operated Rocking-Contact type speed regulator			42	E10512-01-600	91-5143	4444		0	2	1	1	2	Z2002
Z2002A		Commutator assembly with step resistor for speed regulator			42	E10533-01-500	51-5916	4446	1	1	1	2	1	3	Z2002A
Z2002B		Same as Z2001B								-		-		-	
Z2002C		Same as Z2001C								-		-		-	
Z2002D		Same as Z2001D								-		-		-	
Z2002E		Same as Z2001E								-		-		-	
Z2002F		Same as Z2001F								-		-		-	
Z2003	Filter for B2009 leads	Radio interference filter for 1 amp 115 v ac			32	EN-108	92-5139	4460	1	1	2	2	1	2	Z2003, Z2004, Z2005
Z2004	Filter for B2010 leads	Same as Z2003								-		-		-	
Z2005	Filter for Z2001A, Z2002A negative leads	Same as Z2003								-		-		-	
Z2006	Filter for B2009, B2010, Z2010A, & Z2002A leads	Radio interference filter for 3 amp 115 v dc			32	EN-107	92-5138	4466	1	1	2	2	1	2	Z2006
Z2103	Filter for 211241 motor armature leads	R.F. filter assembly			28		71A-2	4474	1	1	2	2	1	2	Z2103

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Revised 10-3-44

(4)

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR MOTOR-ALTERNATOR AND CONTROL UNITS

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP.		TENDER		STOCK		ALL SYMBOL DESIGNATIONS INVOLVED
									BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	
		ASSEMBLIES (Cont'd)													
Z2104	Filter for 211241 motor & alternator DC field leads	R.F. filter assembly			28		71A-3	4476	1	1	2	2	** 1	2	Z2104
Z2105	Filter for 211241 alternator armature leads	R.F. filter assembly			28		71A-1	4478	1	1	2	2	1	2	Z2105
		MISCELLANEOUS PARTS													
		Bearing puller adapter				E7860-04-600	118-5257	4490		0		0	1	1	

0 No spares furnished
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Revised 10-3-44

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR USE ON SO-4 RADAR EQUIPMENT

PART									SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP.		TENDER		STOCK		ALL SYMBOL DESIGNATIONS INVOLVED
									BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	
		TOOLS													
	Used on indicator	Open end offset wrench			150		118-5231	6000		1		1		2	
	Used on indicator	Special wrench for indicator front panel			150		118-5230P1	6001		1		1		2	
	Used on indicator accessory control unit	Wrench, Allen #8			28		118-5168	6002		1		1		2	
	Used on indicator	Wrench, Allen #10					118-5169	6003		1		1		2	
	Used on indicator	Indicator test cable			28		3C-326	6004		1		1		2	
	Used on indicator	Indicator test cable			28		3C-327	6005		1		1		2	
	Used on indicator	Auxiliary test cable			28		34C-37	6006		1		1		2	
	For use on transmitter-receiver potting pulse cable connector	Injector gun and metallic hose assembly			129		118-5251G1	6007		1		3		3	
	For use on transmitter-receiver injector gun cartridge	Dow-Corning #4 ignition sealing compound (4 ozs.)			129	#4	23-5068P2	6008		1		9		12	
	For use on receiver	Test lead			151	#368	118-5261	6009		1		1		2	
	For use on receiver	Alignment screw driver			3		118-5252	6010		1		1		2	
	For use on receiver	Tube			19		5B61-377P1	6011		1		1		2	
		SPECIAL CABLES & MISCELLANEOUS WIRES													
		Co-axial cable			60		73-5000	6100		25'		50'		100'	
		#14 wire tinned bus			80		73-5055	6101		5'		10'		20'	
		#20 wire tinned bus			80		73-5015	6102		5'		10'		20'	
		#14 wire - aircraft type green			73		73-5057	6103		5'		50'		100'	
		#14 wire - aircraft type brown, green tracer			73		73-5006	6104		5'		50'		100'	
		#18 wire - aircraft red			73		73-5003	6105		5'		50'		100'	
		#18 wire - aircraft green			73		73-5004	6106		5'		50'		100'	
		#18 wire - aircraft blue			73		73-5039	6107		5'		50'		100'	
		#18 wire - aircraft brown, red tracer			73		73-5001	6108		5'		50'		100'	
		#18 wire - aircraft brown, green tracer			73		73-5002	6109		5'		50'		100'	
		#18 wire - aircraft red 5000 v insulated			73		73-5021	6110		5'		50'		100'	

11-4-44

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR USE ON SO-4 RADAR EQUIPMENT

PART								SPARES						
								EQUIP.		TENDER		STOCK		
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	BOX NO.	QUANT.	BOX NO.	QUANT.	BOX NO.	QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		MISCELLANEOUS PARTS & HARDWARE													
	For use on accessory control unit	Fuse clip 9/16" O.D.			58	103A	26-5011	6200		1		1		4	
	For use on accessory control unit and rectifier power unit	Fuse clip 9/16" O.D.	-28002		58		26-5008P1	6201		3		7		28	
	For use on rectifier power unit	Fuse clip	-28003		58		26-5009P1	6202		1		2		8	
		Dehydrator plug package			51		79-5033G1	6203		10		40		100	
		Flexible waveguide 1¼ x 5/8 x 12			120		51-5923P2	6204		0		1		2	
		Flexible waveguide 1¼ x 5/8 x 12			120		51-5988	6205		0		1		2	
		Waveguide (random length 10' to 13')					110T-5038	6206		0		30'		60'	
		Cover flange			121		105-5717P1	6207		0		3		6	
		Choke flange			121		105-5716P2	6208		0		3		6	
		Gasket			132		87-5067	6209		0		12		24	

0 No spares furnished

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-23AFK BEARING CONTROL UNIT
FOR USE WITH MODEL SO-4 RADAR EQUIPMENT

EQUIPMENT SPARES RX-1217
TENDER SPARES RX-1218
STOCK SPARES RX-1219

PART								SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		NAVY TYPE CRP-23AFK BEARING CONTROL UNIT													
		Bearing Control Unit			28	RX-1162	9S-X2	3001		0		0		1	
		MOTORS AND SYNCHRO UNITS													
B1404		Step motor, 70 v			28		115-5095	3010		1		2		3	B1404
B1405		Synchro motor, Mark IV, Model 2, Size 5DG, 90/90 v, 60 ~	-21960	5DG	15	280374	115-5005	3011		1		2		3	B1405
B1406		Synchro motor, Type 1F, 45/90 v, 60 ~	-214972	1F	28		115-5122	3012		1		2		3	B1406
		CAPACITORS													
C1413	P. F. correction capacitor	Capacitor, paper, 3 sections each 10 mfd., 90 v, dc wkg.	-48I547	RE 48A 300 RE 13A 488D	15	18-F-72	35-5065	3020		1		2		3	C1413
		TERMINAL STRIPS AND MISCELLANEOUS ELECTRICAL PARTS													
E1416	Terminal strip	Terminal strip, bakelite barrier type, 5 solder terminals with 6-32 x ¾" binder head screws			21	5-141-¾W	47-5045P3	3031		0		0		1	E1416
E1417	Terminal strip, antenna	Terminal strip, bakelite barrier type, 6 solder terminals with 6-32 x ¾" binder head screws			21	6-141-¾W	47-5043P3	3032		0		0		2	E1417, E1418
E1418	Terminal strip, antenna	Same as E1417								-		-		-	
		CONTACTORS AND RELAYS													
K1401	Synchronizing relay	Relay, DPDT, with aux., DT contact, ceramic base, 115 v, 60 ~ coil	-29181		38	1177CBF	71-5005P1	3041		1		2		3	K1401
		SWITCHES, INTERLOCKS AND THERMOSTATS													
S1408	Synchronizing switch	Switch, micro, SPDT, roller type			28	2RQ91	28-5129	3051		1		1		2	S1408, S1409
S1409	Synchronizing switch	Same as S1408								-		-		-	
		MECHANICAL SPARES													
		Captive screw			28		9-5199P1	3071		0		2		4	
		Gasket			28		9S-47P1	3072		1		2		4	
		Bearing				ND-77502	102-5083	3073		1		2		2	
		Bearing				#37KDD	102-5145	3074		2		6		6	

0 No spares furnished
- For spares see reference given in "Description" column

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR NAVY TYPE CRP-23AFK BEARING CONTROL UNIT
FOR USE WITH MODEL SO-4 RADAR EQUIPMENT

EQUIPMENT SPARES RX-1217
TENDER SPARES RX-1218
STOCK SPARES RX-1219

PART								SPARES						
SYMBOL DESIG.	FUNCTION	DESCRIPTION	NAVY TYPE NUMBER	NAVY DWG. OR SPEC. NUMBER	MFR.	MFR. DESIG.	CONTRACTORS DWG. AND PART NUMBER	TAG NO.	EQUIP. BOX NO.	EQUIP. QUANT.	TENDER BOX NO.	TENDER QUANT.	STOCK BOX NO.	STOCK QUANT.	ALL SYMBOL DESIGNATIONS INVOLVED
		MECHANICAL SPARES (Cont'd)													
		Spring					88-5130P1	3075		1		2		5	
		Loading spring					36-5134	3076		3		6		15	
		Key, ¼ x ¼ x 2					9S-59P2	3077		1		2		2	
		Key, ¼ x ¼ x 1½					9S-59P1	3078		1		2		2	
		Brush block					9S-34P1	3079		1		4		6	
		Pressure spring					9S-27P1	3080		2		4		10	
		Contact brush					9S-35G1	3081		2		6		10	
		Contact spring					9S-28P1	3082		2		4		10	
		Loading spring				N.D-S-15	36-5161	3083		1		2		5	
		Spring 3/8 O.D. x ¼ x .031 wire					88-5121	3084		1		2		5	
		Spring					26A2-650	3085		1		2		5	

TABLE IV
LIST OF MANUFACTURERS FOR MODELS

Code No.	Mfr. Prefix	Name	Address
1	CBZ	Allen-Bradley Co.	Milwaukee, Wis.
2	CPH	American Phenolic Corp.	1830 S. 54th Ave., Chicago, Ill.
3		American Radio Hardware Co.	476 Broadway, New York, N. Y.
4	CHH	Arrow-Hart and Hegeman Electric Co.	103 Hawthorn, Hartford, Conn.
5	CBX	Bodine Electric Co.	2254 W. Ohio St., Chicago, Ill.
6		Bryant Electric Co.	Bridgeport, Conn.
7		Cinaudagraph Corp.	2 Selleck St., Stamford, Conn.
8	CMC	Clarostat Mfg. Co. Inc.	285 N. Sixth St., Brooklyn, N. Y.
9	CD	Cornell-Dubilier Corp.	Hamilton Blvd., So. Plainfield, N. J.
10		Coto-Coil Co., Inc.	71 Willard St., Providence, R. I.
11		Electric Motor Corp.	1215 State St., Racine, Wis.
12		Federal Telephone and Radio Corp.	250 South St., Newark, N. J.
13		Fenwal, Inc.	Ashland, Mass.
14	CFI	Ford Instrument Co.	Lawson St. and Nelson Ave., Long Island, N. Y.
15	CG	General Electric Co.	Schenectady, N. Y.
16		General Electric Co. (Nela Div.)	Hoboken, N. J.
17		Globe Rubber Works	655 Atlantic Ave., Boston, Mass.
18	CHD	Hardwicke-Hindle, Inc.	40 Herman St., Newark, N. J.
19	CHS	Sylvania Electric Products, Inc.	60 Boston St., Salem, Mass. and Emporium, Pa.
20	CIR	International Resistance Co.	401 N. Broad St., Philadelphia, Pa.
21	CJC	Jones, Howard B.	2300 Wabansia Ave., Chicago, Ill.
22	CLF	Littlefuse, Inc.	4791 Ravenswood Ave., Chicago, Ill.
23		L-R Mfg. Co.	Torrington, Conn.
24		Morse, F. W.	301 Congress St., Boston, Mass.
25		Mu Switch Co.	Canton, Mass.
26	COC	Oak Mfg. Co.	1260 Clybourn Ave., Chicago, Ill.
27	COM	Ohmite Mfg. Co.	4837 Flournoy St., Chicago, Ill.
28	CRP	Raytheon Mfr. Co.	Seyon St., Waltham, Mass.
29	CRC	RCA Mfg. Co.	Harrison, N. J.
30	CAN	Sangamo Electric Co.	11th St. and Converse Ave., Springfield, Ill.
31	CFW	Sickles, F. W.	297 Main St., Springfield, Mass.
32	CSL	Solar Mfg. Co.	Bayonne, N. J.
33	CSF	Sprague Specialties Co.	No. Adams, Mass.
34	CSA	Stackpole Carbon Co.	1942 Tannery St., St. Mary's, Pa.
35	CUF	Ucinite Co.	459 Watertown St., Newton, Mass.
36	CGC	General Control Co.	243 Broadway, Cambridge, Mass.
37	CLL	Leland Electric Co.	Dayton, Ohio
38	CLR	Leach Relay Co., Inc.	5915 Avalon Blvd., Los Angeles, Calif.
39	CSQ	Spencer Thermostat Co.	Attleboro, Mass.
40	CAS	American Lava Corp.	Chattanooga, Tenn.
41	CMU	Micro-Switch Corp.	1 East Spring St.. Freeport, Ill.
42		Allis Chalmers Mfg. Co.	Milwaukee, Wis.
43		Hagerty Co.	Cohasset, Mass.

Revised 11-4-44

TABLE IV
LIST OF MANUFACTURERS FOR MODELS
SO-4

Code No.	Mfr. Prefix	Name	Address
44		Selectar Mfg. Co.	30 W. 15th St., New York, N. Y.
45		Fay and Scott Co.	Dexter, Maine
46		The Brown-Brockmeyer Co.	Dayton, Ohio
47	CW	Western Electric Co.	120 Broadway, New York, N. Y. and 100 Central Ave., Kearney, N. J.
48	CNA	National Company	61 Sherman St., Malden, Mass.
49		Lear Avia, Inc.	Piqua, Ohio
50		Stupakoff Cermaic Mfg. Co.	Hillview Ave., Latrobe, Pa.
51		Chandler Evans Corp.	South Meriden, Conn.
52		Simplex Wire and Cable Co.	79 Sidney St., Cambridge, Mass.
53		S. S. White Dental Mfg. Co.	10 East 40th St. New York, N. Y.
54	CMG	Cinch Mfg. Co.	2335 West Van Buren St., Chicago, Ill.
55		Vibration Eliminator Co.	8-22 Astoria Blvd., Astoria, Long Island, N. Y.
56	CYA	Alden Products Co.	117 N. Main St., Brockton, Mass.
57	CFA	Bussman Mfg. Co.	University and Jefferson St., St. Louis, Mo.
58		Chase-Shawmut Co.	Newburyport, Mass.
59		Stewart Stamping Corp.	621 East 216th St., New York, N. Y.
60		Belden Mfg. Co.	4647 Van Buren St., Chicago, Ill.
61		Atlantic India Rubber Works	1453 W. Van Buren St., Chicago, Ill.
62		General Motors Corp. (Packard Electric Div.)	Warren, Ohio
63		Tyer Rubber Co.	Andover, Mass.
64	CEE	Thomas A. Edison Co., Inc.	West Orange, N. J.
65	CEL	Electrons, Inc.	125 Sussex Ave., Newark, N. J.
66		Lord Mfg. Co.	Erie, Pa.
67		Phelps Dodge Copper Products Co., Inca Div.	Fort Wayne, Indiana
68		Plastics Turning Co.	Leominster, Mass.
69		Pure Pac Co.	511 East 72nd St., New York, N. Y.
70		Minnesota Mining Co.	St. Paul, Minn.
71		Boston Woven Hose and Rubber Co.	29 Hampshire, Cambridge, Mass.
72	CSD	Struthers Dunn Inc.	1315 Cherry St., Philadelphia, Pa.
73		Gavitt Mfg. Co.	Brookfield, Mass.
74		Boston Insulated Wire and Cable Co.	65 Bay St., Dorchester, Mass.
75		Allied Control Co., Inc.	227 Fulton St., New York N. Y.
76		Canfield Rubber Co.	Bridgeport, Conn.
77		Garlock Packing Co.	Elmira, N. Y.
78		Rome Cable Corp.	Rome, N. Y.
79		Flexo Wite Co.	Syracuse, N. Y.
80		General Cable Co.	420 Lexington Ave., New York, N.Y.
81		Wirt Co.	5221 Green St., Germantown, Pa.
82		Lafayette Radio Co.	110 Federal St., Boston, Mass.
83		General Radio Co.	Cambridge, Mass.
84		Amperite Co.	563 Broadway, New York, N. Y.
85		Selenium Corp, of America	1800 West Pico Blvd.. Los Angeles, Calif.

Revised 11-4-44

TABLE IV
LIST OF MANUFACTURERS FOR MODELS
SO-4

Code No.	Mfr. Prefix	Name	Address
86		National Carbon Co.	Cleveland, Ohio
87		Ohio Electric Co.	5902 Maurice Ave., Cleveland, Ohio
88		Bogue Electric Co.	West Paterson, New Jersey
89		The Murray Co.	27 Damrell St., South Boston, Mass.
90		Edwin L. Wiegand Co.	7500 Thomas Blvd., Pittsburgh, Pa.
91		B. F. Goodrich Co.	Akron, Ohio
92		Lee Engineering & Mfg. Co.	2025 West Wisconsin Ave., Milwaukee, Wis.
93		Federal Bearings Co. Inc.	West Poughkeepsie, N. Y.
94		Chrysler Corp.	Detroit, Michigan
95		American Flexible Coupling Co.	1800 Pittsburgh Ave., Erie, Pa.
96		John Oster Mfg. Co.	Genoa, Illinois
97		Thomas Flexible Coupling Co.	1938 So. Main St., Warren, Pa.
98		Cutler Hammer	Milwaukee, Wisconsin
99	CABS	Palmer Electric & Mfg. Co.	Wakefield, Mass.
100		Russell Electric Co.	370 W. Huron St., Chicago, Ill.
101		Guardian Electric Co.	1620 W. Walnut St., Chicago, Ill.
102		Fansteel Metallurgical Co.	Chicago, Ill.
103		Dillingham & Lewis	Indianapolis, Ind.
104		Morganite Brush Co.	3302 48th St., Long Island City, N. Y.
105		P. R. Mallory	3029 E. Washington St., Indianapolis, Ind.
106		General Motors Corp. (New Departure Div.)	Murden St., Bristol, Conn.
107		Norma Hoffmann Bearings Corp.	Stamford, Conn.
108		Timken Roller Bearing Co.	Canton, Ohio
109		Ark-Les Switch Corp.	51 Watertown St., Watertown, Mass.
110		E. F. Johnson Co.	Waseca, Minn.
111		Culver - Stearns	Worcester, Mass.
112		Paragon Electric Co.	Chicago, Illinois
113		Bendix Aviation (Eclipse Pioneer Div.)	Bendix, N. J.
114		Marathon Electric Corp.	Wausau, Wis.
115		Instrument Resistor Co.	30 Amity St., Little Falls, N. J.
116		Westinghouse Electric & Mfg. Co.	Hill St., E. Pittsburgh, Pa. & 10 High St., Boston, Mass.
117		Birtcher Corp.	5087 Huntington Dr., No. Los Angeles, Calif.
118		Economy Fuse & Mfg. Co.	Greenview Ave., Chicago, Ill.
119		Formica Insulation Co.	4615 Spring Grove Ave., Cinn. Ohio
120		American Brass Co.	Waterbury 88, Conn.
121		Whiting - Davis	Plainville, Mass.
122		Boston Metal Products Co.	85 Boylston St., Boston, Mass.
123		Victory Plastic Co.	Scabbard St., Hudson, Mass.
124		Webster Co.	N. Attleboro, Mass.
125		Armstrong Cork Co.	1010 Concord St., Lancaster, Pa.
126		Goodyear Rubber Sundries	New Haven, Conn.
127		Howard Clock Co.	Waltham, Mass.
128		Waltham Screw Machine Co.	Waltham, Mass.
129		Alemite Co. of Boston	Boston, Mass.
130		Davidson Rubber Co.	Charlestown, Mass.
131		Kitson Co.	Philadelphia 2, Pa.

Revised 11-4-44

TABLE IV
LIST OF MANUFACTURERS FOR MODELS
SO-4

Code No.	Mfr. Prefix	Name	Address
132		Stowe - Woodward	181 Oak St., Newton Upper Falls, Mass.
133		Franklin Mfg. Co.	Norwood, Mass.
134		Assembly Co.	Pearl St., Boston, Mass.
135		Bridgewater Machine Co.	Akron, Ohio
136		Lynn Screw Inc.	Lynn, Mass.
137		I. G. Marston Co.	230 Ruggles St., Boston, Mass.
138		George Knight	Brockton, Mass.
139		J. W. Greer	119 Windsor St., Cambridge, Mass.
140		Hardware Products	103 Richmond St., Boston, Mass.
141		Radio Essentials	69 Wooster St., New York City 12, N. Y.
142		Waushakum Machine Co.	Ashland, Mass.
143		Bendon Machine Co.	142 Pearl St., Chelsea, Mass.
144		Wheeler Products Co.	430 Kinsley Ave., Providence, R. I.
145		United Machine Co.	South St., Stoughton, Mass.
146		George Grant	25 Kempton Pl. W. Newton 65, Mass.
147		P. G. Peck	Laurence, Mass.
148		Automatic Signal Corp.	East Norwalk, Conn.
149		Transit Machine Co.	108 Mass. Ave., Boston, Mass.
150		Apco - Mossburg	Attleboro, Mass.
151		Insuline Corp. of America	35th Ave & 36th St., Long Island City, N. Y.
152		Waldes - Koh-i-noor	Long Island City No. 22, New York 4, N. Y.
153		Fafnir Bearing Co.	Victory Sq., New Brittain, Conn.
154		Schmitzer Alloy	164 Broadway, Elizabeth, N. J.
155		Boston Cutting Die Co.	Boston, Mass.
156		A. Schrader's Son	470 Vanderbilt Ave., Brooklyn, N. Y.
157		G. M. Labaratories Inc.	4312 N. Knox Ave., Chicago, Ill.
158		Dow - Corning Corp.	Midland, Mich.
159		R. W. Cramer	Miller St., Centerbrook, Conn.
160		Norwood Machine Works	Norwood, Mass.
161		G. W. Bollman Co.	Philadelphia, Pa.
162		Crompton, Knowles	93 Grand St., Worcester, Mass.
163		Allied Machine Co.	6 Water St., Waltham, Mass.
164		Conn. Spring Co.	
165		Handee Spring Mfg. Co.	2074 Park St. Hartford, Conn.
166		Bowdoin Sq. Products.	Boston, Mass.
167		MacNeil Machine Co.	87 Rumford St., Waltham, Mass.
168		Evans Case Co.	East St., No. Attleboro, Mass.

Revised 11-4-44

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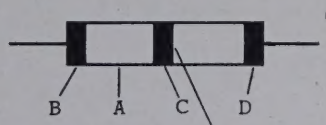
TABLE V
APPLICABLE COLOR CODES AND MISCELLANEOUS DATA

RMA COLOR CODE FOR RESISTORS

COLOR	A 1ST DIGIT	B 2ND DIGIT	C CIPHERS
Black	-	0	.0
Brown	1	1	0
Red	2	2	00
Orange	3	3	000
Yellow	4	4	0000
Green	5	5	00000
Blue	6	6	000000
Purple	7	7	0000000
Gray	8	8	00000000
White	9	9	--

D - Tolerance Code:

Gold = 5% Silver = 10% Omit = 20%

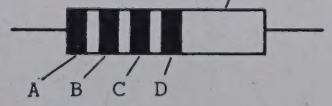


Original Color Arrangement for Axial Leads

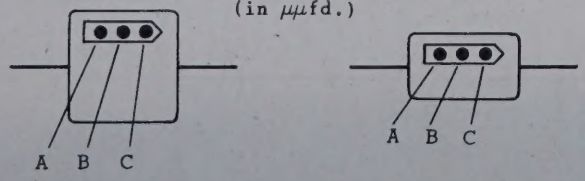
Band or Dot

Background Color

New Color Arrangement for Axial Leads



USE ABOVE TABLE FOR CAPACITORS
(in $\mu\mu$fd.)

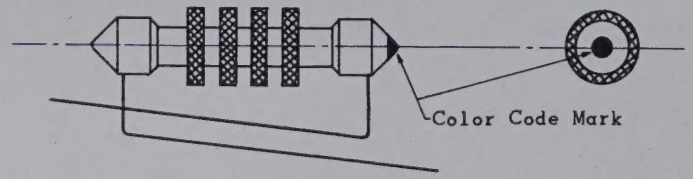


COLOR CODE FOR WIRING

A) Brown with green tracer - all AC connected to external source of supply.
B) Brown with red tracer - all AC isolated from external source of supply.
C) Red - DC circuits, any voltage
D) Green - all signal circuits

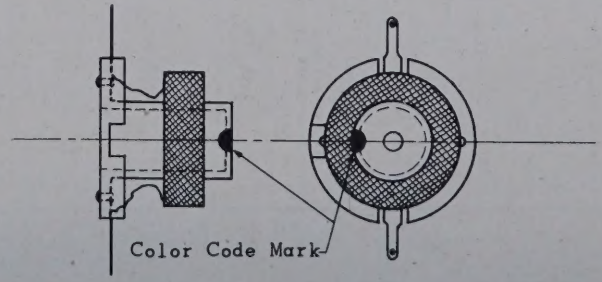
COLOR CODE FOR FOUR PI R.F. CHOKES

Orange 2.5 mh.
Red 5 mh.



COLOR CODE FOR SINGLE PI R.F. CHOKES

Red 5 mh.
Yellow 7.5 mh.
Green 10 mh.
Blue 25 mh.



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SECTION VII

MAIN SCHEMATICS FOR NAVY MODEL SO-4 RADAR EQUIPMENT

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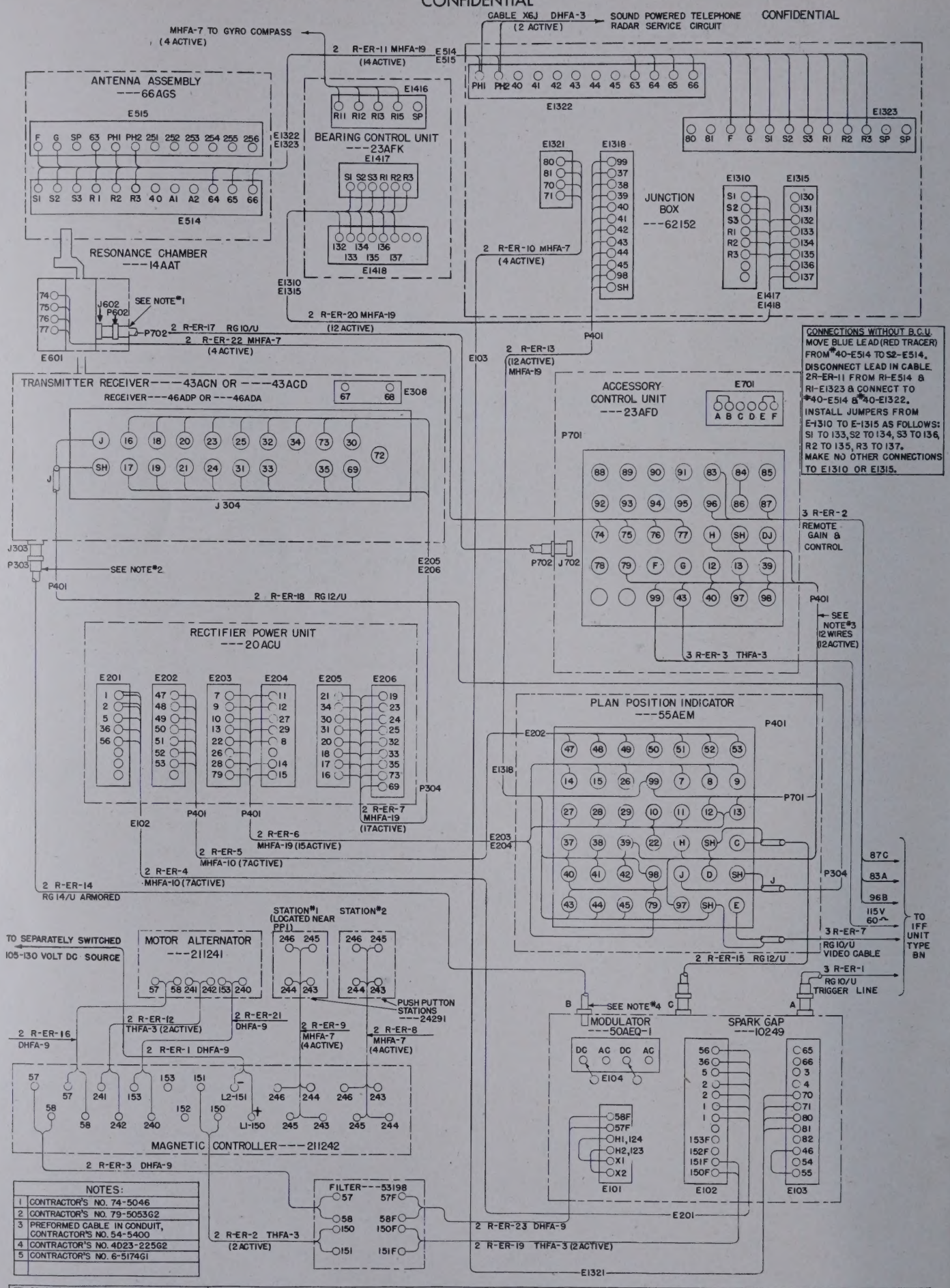
MHFA-7 TO GYRO COMPASS (4 ACTIVE)
CABLE X6J DHFA-3 (2 ACTIVE)
SOUND POWERED TELEPHONE RADAR SERVICE CIRCUIT
CONFIDENTIAL
2 R-ER-11 MHFA-19 (14 ACTIVE)
E514 E515
ANTENNA ASSEMBLY ---66AGS
E515
F G SP 63 PHI PH2 251 252 253 254 255 256
E1322 E1323
SI S2 S3 R1 R2 R3 40 A1 A2 64 65 66
E514
BEARING CONTROL UNIT ---23AFK
E1416
R11 R12 R13 R15 SP
E1417
SI S2 S3 R1 R2 R3
132 134 136 133 135 137
E1418
E1322
PH1 PH2 40 41 42 43 44 45 63 64 65 66
E1323
80 81 F G SI S2 S3 R1 R2 R3 SP SP
E1321
80 81 70 71
E1318
99 37 38 39 40 41 42 43 44 45 98 SH
JUNCTION BOX ---62152
E1310
SI S2 S3 R1 R2 R3
E1315
130 131 132 133 134 135 136 137
E1417 E1418
2 R-ER-10 MHFA-7 (4 ACTIVE)
RESONANCE CHAMBER ---14AAT
74 75 76 77
J602 P602
SEE NOTE*1
P702
2 R-ER-17 RG10/U
2 R-ER-22 MHFA-7 (4 ACTIVE)
E601
E1310 E1315
2 R-ER-20 MHFA-19 (12 ACTIVE)
P401
E103
2 R-ER-13 (12 ACTIVE) MHFA-19
CONNECTIONS WITHOUT B.C.U.
MOVE BLUE LEAD (RED TRACER) FROM *40-E514 TO S2-E514.
DISCONNECT LEAD IN CABLE 2R-ER-11 FROM R1-E514 & R1-E1323 & CONNECT TO *40-E514 & *40-E1322.
INSTALL JUMPERS FROM E-1310 TO E-1315 AS FOLLOWS:
S1 TO 133, S2 TO 134, S3 TO 136, R2 TO 135, R3 TO 137.
MAKE NO OTHER CONNECTIONS TO E1310 OR E1315.
TRANSMITTER RECEIVER ---43ACN OR ---43ACD
RECEIVER ---46ADP OR ---46ADA
67 68
E308
J 16 18 20 23 25 32 34 73 30
SH 17 19 21 24 31 33 35 69 72
J
J 304
ACCESSORY CONTROL UNIT ---23AFD
E701
A B C D E F
P701
88 89 90 91 83 84 85
92 93 94 95 96 86 87
74 75 76 77 H SH DJ
78 79 F G 12 13 39
99 43 40 97 98
3 R-ER-2 REMOTE GAIN & CONTROL
P401
SEE NOTE*3 12 WIRES (12 ACTIVE)
3 R-ER-3 THFA-3
J303
P303
SEE NOTE*2
P401
E205 E206
P702 J702
2 R-ER-18 RG12/U
RECTIFIER POWER UNIT ---20ACU
E201 1 2 5 36 56
E202 47 48 49 50 51 52 53
E203 7 9 10 13 22 26 28 79
E204 11 12 27 29 8 14 15
E205 21 34 30 31 20 18 17 16
E206 19 23 24 25 32 33 35 73 69
P304
2 R-ER-7 MHFA-19 (17 ACTIVE)
E102
P401
P401
2 R-ER-6 MHFA-19 (15 ACTIVE)
2 R-ER-5 MHFA-10 (7 ACTIVE)
2 R-ER-4 MHFA-10 (7 ACTIVE)
2 R-ER-14 RG14/U ARMORED
PLAN POSITION INDICATOR ---55AEM
P401
E202
47 48 49 50 51 52 53
E1318
14 15 26 99 7 8 9
P701
27 28 29 10 11 12 13
E203 E204
37 38 39 22 H SH C
40 41 42 98 J D SH J
43 44 45 79 97 SH E
P304
87C
83A
96B
115V 60~
TO IFF UNIT TYPE BN
3 R-ER-7 RG10/U VIDEO CABLE
2 R-ER-15 RG12/U
3 R-ER-1 RG10/U TRIGGER LINE
STATION*1 (LOCATED NEAR PPI)
STATION*2
246 245
244 243
TO SEPARATELY SWITCHED 105-130 VOLT DC SOURCE
MOTOR ALTERNATOR ---211241
57 58 241 242 153 240
PUSH PUTTON STATIONS ---24291
2 R-ER-16 DHFA-9
2 R-ER-12 THFA-3 (2 ACTIVE)
2 R-ER-21 DHFA-9
2 R-ER-9 MHFA-7 (4 ACTIVE)
2 R-ER-8 MHFA-7 (4 ACTIVE)
2 R-ER-1 DHFA-9
MAGNETIC CONTROLLER ---211242
57 58 153 151 L2-151 246 244 246 243
57 58 241 242 240 152 150 L1-150 245 243 245 244
2 R-ER-3 DHFA-9
B SEE NOTE*4 C A
MODULATOR ---50AEQ-1
DC AG DC AG
E104
58F 57F H1,124 H2,123 X1 X2
E101
SPARK GAP ---10249
56 36 5 2 2 1 1
153F 152F 151F 150F
E102
65 66 3 4 70 71 80 81 82 46 54 55
E103
NOTES:
1 CONTRACTOR'S NO. 74-5046
2 CONTRACTOR'S NO. 79-5053G2
3 PREFORMED CABLE IN CONDUIT, CONTRACTOR'S NO. 54-5400
4 CONTRACTOR'S NO. 4D23-22562
5 CONTRACTOR'S NO. 6-5174G1
FILTER ---53198
57 57F 58 58F 150 150F 151 151F
2 R-ER-2 THFA-3 (2 ACTIVE)
E201
2 R-ER-23 DHFA-9
2 R-ER-19 THFA-3 (2 ACTIVE)
E1321

RAYTHEON MFG. CO. WALTHAM, MASS.	EXT. CABLING SO-4 WITH A.C.U. & B.C.U.	C-9K-7	SUB NO. 4

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CABLE NO. AND SIZE	WIRE SEQUENCE	WIRE NO.	WIRE COLOR	FROM	TERM. NO.	TERM. SIZE	TO	TERM. NO.	TERM. SIZE	FUNCTION	COND. AMP.	MAX. V DROP
2 -A-EA-1	1		BLACK	LINE SWITCH NOT SUPPLIED			MAG. CONTROLLER	X-1757	8	MAIN D.C. POWER SUPPLY +	.30	2.9
MHFA-9	2		WHITE	WITH RADAR				LX-1570	8	MAIN D.C. POWER SUPPLY -	.30	2.9
(18 Active)												
2 -A-EA-2	1		BLACK	MAG. CONTROLLER	151	8	FILTER	150	3	D. C. SUPPLY +	.6	.11
MHFA-3	2		WHITE		151	8		151	3	D. C. SUPPLY -	.6	.11
(2 Active)												
2 -A-EA-3	1		BLACK	MAG. CONTROLLER	57	8	FILTER	57	3	A. C. SUPPLY	.13	.6
MHFA-9	2		WHITE		58	8		58	3	A. C. SUPPLY	.13	.6
(8 Active)												
2 -A-EA-23	1		BLACK	FILTER	527	3	MODULATOR	527	3	A. C. SUPPLY TO MODULATOR	.13	.07
MHFA-9	2		WHITE		528	3		528	3	A.C. SUPPLY TO MODULATOR	.13	.07
(8 Active)												
2 -A-EA-12	1		BLACK	MOTOR ALT.	241	11	MAG. CONTROLLER	241	8	ALTERNATOR FIELD	.5	.03
MHFA-3	8		WHITE		242	11		242	8	MOTOR SHUNT FIELD	.5	.03
(2 Active)												
2 -A-EA-15	1		BLACK	MOTOR ALT.	57	10	MAG. CONTROLLER	57	8	ALTERNATOR OUTPUT	.14	.3
MHFA-9	2		WHITE		58	10		58	8	ALTERNATOR OUTPUT	.14	.3
(2 Active)												
2 A-EA-21	1		BLACK	MAG. CONTROLLER	240	8	MOTOR ALT.	240	10	D. C. MOTOR INPUT	27	.6
MHFA-9	2		WHITE		158	8		153	10	D. C. MOTOR INPUT	27	.5
(2 Active)												
2 -A-EA-10	1		BLACK	FILTER	180F	3	MODULATOR	180F	11	D.C. SUPPLY TO MODULATOR +	.6	.01
MHFA-3	2		WHITE		181F	3		181F	11	-	.5	.01
(2 Active)												
2 -A-EA-14	1		COAXIAL	MODULATOR	8		TRANSMITTER RECEIVER	P303		PULSE		
RG-74/U												
2 -A-EA-16	1		COAXIAL	MODULATOR	C		PLAN POSITION IND.	C		P.P.I. TRIGGER		
RG-12/U	2			MODULATOR	P105		PLAN POSITION IND.	SH				

CABLE NO. AND SIZE	WIRE SEQUENCE	WIRE NO.	WIRE COLOR	FROM	TERM. NO.	TERM. SIZE	TO	TERM. NO.	TERM. SIZE	FUNCTION	COND. AMP.	MAX. V DROP
2 -A-EA-4	1		BLACK	MODULATOR	1	11	RECT. POWER UNIT	1	11	A. C. POWER	3.2	.4
MHFA-10	2		WHITE		1	11		1	11	A. C. POWER	3.0	.4
9 (7 Active)	3		RED		2	11		2	11	A. C. POWER	3.1	.31
	4		GREEN		2	11		2	11	A. C. POWER	3.1	.31
	5		ORANGE		5	11		5	11	CONTROL CIRCUIT K101	.12	.04
	6		BLUE		35	11		35	11	A. C. INPUT TO T101	1.3	.2
	7		WHITE-BLACK		55	11		55	11	CONTROL CIRCUIT K101	0.12	.04
2 -A-EA-7	1		BLACK	RECT. POWER UNIT	15	11	TRANSMITTER RECEIVER	15	8	RECEIVER TUNING	.01	1.0
MHFA-10	2		WHITE		17	11		17	8	RECEIVER GAIN	.01	1.0
(17 Active)	3		RED		18	11		18	8	CONTROL CIRCUIT K101	.12	.03
	4		GREEN		19	11		19	8	CONTROL CIRCUIT K101	.12	.03
	5		ORANGE		20	11		20	8	CONTROL CIRCUIT TO K201	.12	.03
	6		BLUE		21	11		21	8	CONTROL CIRCUIT TO K201	.12	.03
	7		WHITE-BLACK		23	11		23	8	T.R. BLOWER MOTOR	.4	.08
	8		RED-BLACK		24	11		24	8	CONTR.CIRC. K3101 & K3102	.22	.05
	9		GREEN-BLACK		25	11		25	8	CONTROL CIRCUIT K3102	.12	.03
	10		ORANGE-BLACK		30	11		30	8	RECEIVER POWER SUPPLY	.01	2.0
	11		BLUE-BLACK		31	11		31	8	RECEIVER POWER SUPPLY	3.0	2.0
	12		BLACK-WHITE		32	11		32	8	RECEIVER POWER SUPPLY	.05	2.0
	13		RED-WHITE		33	11		33	8	RECEIVER POWER SUPPLY	.05	2.0
	14		GREEN-WHITE		34	11		34	8	A.C. SUPPLY TO T.R.	1.55	.33
	15		BLUE-WHITE		35	11		35	8	A.C. SUPPLY TO T.R.	1.55	.33
	16		BLACK-RED		50	11		50	8	CONTROL CIRCUIT K3101	.12	.03
	17		WHITE-RED		73	11		73	8	A.C. SUPPLY TO T.R.	.25	.05
2 -A-EA-6	1		BLACK	P.R. STATION #2	240	13	MAG CONTROLLER	240	11	MOTOR ALT. CONTROL CIRCUIT	.3	.04
MHFA-7	2		WHITE		244	10		244	8	MOTOR ALT. CONTROL CIRCUIT	.3	.04
(4 Active)	3		RED		245	10		245	8	MOTOR ALT. CONTROL CIRCUIT	.3	.04
	4		GREEN		245	10		245	8	MOTOR ALT. CONTROL CIRCUIT	.3	.04
2 -A-EA-8	1		BLACK	P.R. STATION #1	243	10	MAG. CONTROLLER	243	8	MOTOR ALT. CONTROL CIRCUIT	.2	.04
MHFA-7	2		WHITE		244	10		244	8	MOTOR ALT. CONTROL CIRCUIT	.3	.04
(4 Active)	3		RED		245	10		245	8	MOTOR ALT. CONTROL CIRCUIT	.3	.04
	4		GREEN		245	10		245	8	MOTOR ALT. CONTROL CIRCUIT	.2	.04

CABLE NO. AND SIZE	WIRE SEQUENCE	WIRE NO.	WIRE COLOR	FROM	TERM. NO.	TERM. SIZE	TO	TERM. NO.	TERM. SIZE	FUNCTION	COND. AMP.	MAX. V DROP
2 -A-EA-5	1		BLACK	RECT. POWER UNIT	7	11	PLAN POSITION IND.	7	3	2NV D.C. FROM AUX. RECT.	1.35	.48
MHFA-10	2		WHITE		8	11		8	3	CONTROL CIRCUIT FOR K201	.12	.02
(18 Active)	3		RED		9	11		9	3	CONTROL CIRCUIT FOR K201	.12	.02
	4		GREEN		10	11		10	3	2NV D.C. FROM AUX. RECT.	1.35	.48
	5		ORANGE		11	11		11	3	CONTROL CIRCUIT K201	.12	.02
	6		BLUE		12	11		12	3	A. C. SUPPLY TO INDICATOR	2.0	.27
	7		WHITE-BLACK		13	11		13	3	A. C. SUPPLY TO INDICATOR	2.0	.27
	8		RED-BLACK		14	11		14	3	RECEIVER GAIN	.01	1.0
	9		GREEN-BLACK		15	11		15	3	RECEIVER TUNE	.01	1.0
	10		ORANGE-BLACK		22	11		22	3	CONTROL CIRCUIT K101	.12	.02
	11		BLUE-BLACK		25	11		25	3	RECEIVER TUNE	.01	1.0
	12		BLACK-WHITE		27	11		27	3	RECEIVER TUNE	.01	1.0
	13		RED-WHITE		28	11		28	3	RECEIVER GAIN	.02	1.0
	14		GREEN-WHITE		29	11		29	3	RECEIVER GAIN	.02	1.0
	15		BLUE-WHITE		79	11		79	3	CONTROL CIRCUIT K3101	.12	.02
2 -A-EA-9	1		BLACK	RECT. POWER UNIT	47	11	PLAN POSITION IND.	47	3	INDICATOR POWER SUPPLY	.06	8.0
MHFA-10	2		WHITE		48	11		48	3	INDICATOR POWER SUPPLY	.06	2.0
(7 Active)	3		RED		49	11		49	3	INDICATOR POWER SUPPLY	.01	8.0
	4		GREEN		50	11		50	3	INDICATOR POWER SUPPLY	.15	.5
	5		ORANGE		51	11		51	3	INDICATOR POWER SUPPLY	.01	1.0
	6		BLUE		52	11		52	3	INDICATOR POWER SUPPLY	1.0	.14
	7		WHITE-BLACK		53	11		53	3	INDICATOR POWER SUPPLY	1.0	.14
2 -A-EA-13	1		BLACK	JUNCTION BOX	37	11	PLAN POSITION IND.	37	3	ANT. MOTOR REVERSING RELAY	.12	.03
MHFA-10	2		WHITE		38	11		38	3	ANT. MOTOR REVERSING RELAY	.12	.03
(12 Active)	3		RED		39	11		39	3	ANT. MOTOR REVERSING RELAY	.12	.03
	4		GREEN		40	11		40	3	SYNCHRONIZATION	.12	.03
	5		ORANGE		41	11		41	3	SYNCHRO CIRCUIT	.1	3.0
	6		BLACK		42	11		42	3	SYNCHRO EXCITATION	1.0	.2
	7		WHITE-BLACK		43	11		43	3	SYNCHRO EXCITATION	.6	.12
	8		RED-BLACK		44	11		44	3	SYNCHRO	.1	3.0
	9		GREEN-BLACK		45	11		45	3	SYNCHRONIZATION	.12	.03
	10		ORANGE-BLACK		98	11		98	3	SHIPS HEAD FLASHER	.01	2.0
	11		BLUE-BLACK		99	11		99	3	SYNCHRO EXCITATION	1.6	.4
	12		BLACK-WHITE		54	11		54	3	SHIPS HEAD FLASHER	.01	3.0

CABLE NO. AND SIZE	WIRE SEQUENCE	WIRE NO.	WIRE COLOR	FROM	TERM. NO.	TERM. SIZE	TO	TERM. NO.	TERM. SIZE	FUNCTION	COND. AMP.	MAX. V DROP
2 -A-EA-11	1		BLACK	JUNCTION BOX	PH 1	11	ANTENNA	PH 1	11	SOUND POWERED TELEPHONE		
MHFA-10	2		WHITE		PH 2	11		PH 2	11	SOUND POWERED TELEPHONE		
(14 Active)	3		RED		F	11		F	11	SHIP HEAD FLASHER	.01	3.0
	4		GREEN		G	11		G	11	SHIP HEAD FLASHER	.01	3.0
	5		ORANGE		S 1	11		S 1	11	SYNCHRO CIRCUIT	.1	3.0
	6		BLUE		S 2	11		S 2	11	SYNCHRO CIRCUIT	.1	3.0
	7		WHITE-BLACK		S 3	11		S 3	11	SYNCHRO CIRCUIT	.1	3.0
	8		RED-BLACK		R 1	11		R 1	11	SYNCHRO EXCIT. & SYNCHRONIZATION	.7	.08
	9		GREEN-BLACK		R 2	11		R 2	11	SYNCHRO EXCITATION	.6	.08
	10		ORANGE-BLACK		R 3	11		R 3	11	SYNCHRO SYNCHRONIZATION	.9	.09
	11		BLUE-BLACK		A3	11		A3	11	ANTENNA MOTOR	.5	.17
	12		BLACK-WHITE		54	11		54	11	ANTENNA MOTOR	.5	.17
	13		RED-WHITE		55	11		55	11	ANTENNA MOTOR	.07	.03
	14		GREEN-WHITE		56	11		56	11	ANTENNA MOTOR	.07	.03
2 -A-EA-20	1		BLACK	R.C.U.	S 1	11	JUNCTION BOX	S 1	11	SYNCHRO CIRCUIT	.1	2.0
MHFA-19	2		WHITE		S 2	11		S 2	11	SYNCHRO CIRCUIT	.1	2.0
(12 Active)	3		RED		S 3	11		S 3	11	SYNCHRO CIRCUIT	.1	2.0
	4		GREEN		R 1	11		R 1	11	SYNCHRO EXCIT. & SYNCHRONIZATION	.7	.08
	5		ORANGE		R 2	11		R 2	11	SYNCHRO EXCITATION	.6	.08
	6		BLUE		R 3	11		R 3	11	SYNCHRO SYNCHRONIZATION	.12	.01
	7		WHITE-BLACK		132	11		132	11	SYNCHRONIZATION	.12	.01
	8		RED-BLACK		133	11		133	11	SYNCHRO CIRCUIT	.1	2.0
	9		GREEN-BLACK		134	11		134	11	SYNCHRO EXCITATION	1.0	.06
	10		ORANGE-BLACK		135	11		135	11	SYNCHRO EXCITATION	1.0	.06
	11		BLUE-BLACK		136	11		136	11	SYNCHRO	.1	2.0
	12		BLACK-WHITE		137	11		137	11	SYNCHRONIZATION	.12	.01
2 -A-EA-10	1		BLACK	MODULATOR	70	11	JUNCTION BOX	70	2	SYNCHRO EXCITATION	1.0	.6
MHFA-7	2		WHITE		71	11		71	2	SYNCHRO EXCITATION	1.6	.6
(4 Active)	3		RED		80	11		80	2	ANTENNA MOTOR POWER	.6	.16
	4		GREEN		81	11		81	2	ANTENNA MOTOR POWER	.6	.16
2 -A-EA-*			COAXIAL	RESONANCE CHAMBER	MOD		A. C. U.	P704		RESONANCE CHAMBER INDICATION		
RG-12/U												

CABLE NO. AND SIZE	WIRE SEQUENCE	WIRE NO.	WIRE COLOR	FROM	TERM. NO.	TERM. SIZE	TO	TERM. NO.	TERM. SIZE	FUNCTION	COND. AMP.	MAX. V DROP
2 -A-EA-22	1		BLACK	A. C. U.	74	3	KLYSTRON CHAMBER	74	11	RES. CHAMBER TUNING	.7	.14
MHFA-7	2		WHITE		75	3		75	11	RES. CHAMBER TUNING	.7	.14
(4 Active)	3		RED		76	3		76	11	RES. CHAMBER TUNING	.3	.06
	4		GREEN		77	3		77	11	RES. CHAMBER TUNING	.3	.06
2 -A-EA-24	1		COAXIAL	TRANSMITTER	J	8	P.P.I.	J	3	VIDEO LINE		
RG-12/U	2				SH	8		SH	3			
3 -A-EA-2	1		BLACK	A. C. U.	83	3	I.F.F. SYSTEM	83	11	I.F.F. REMOTE GAIN & CONTR.		
MHFA-3	2		WHITE		87	3		87				
(3 Active)	3		RED		95	3		95				
3 -A-EA-3	1		BLACK	A. C. U.	103	3	I.F.F. SYSTEM	103		I.F.F. SUPPLY 115V, 60 Cy.		
MHFA-3	2		WHITE		99	3		99		I.F.F. SUPPLY 115V, 60 Cy.		
(2 Active)												
3 -A-EA-1	1		COAXIAL	MODULATOR	A		I.F.F. SYSTEM			I.F.F. TRIGGER		
RG-10/U					P106							
3 -A-EA-7	1		COAXIAL	I.F.F. SYSTEM	E		P.P.I.	E	3	I.F.F. VIDEO		
RG-10/U	2				SH			SH	3			
7 PD	1		BLACK	GYRO COMPASS REPEATOR			R.C.U.	411	11	D. S. C. INPUT	.19	25
MHFA-7	2		WHITE	SYSTEM (D.S.C.) 70V. 54S				412	11	D. S. C. INPUT	.19	25
(4 Active)	3		RED					413	11	D. S. C. INPUT	.19	25
	4		GREEN					415	11	D. S. C. INPUT	.19	25
X6J-	1		BLACK	JUNCTION BOX	PH1	11	TO SOUND POWERED					
DHFA-3	2		WHITE		PH2	11	TELEPHONE RADAR					
							SERVICE CIRCUIT					

DR.	DATE	APP'D.	CHK.
FLOW CHART-EXT. CABLING-SO-4 RADAR			
FIRST USED ON			SIZE
RAYTHEON MFG. CO. WALTHAM, MASS.		M-9J-X9	I

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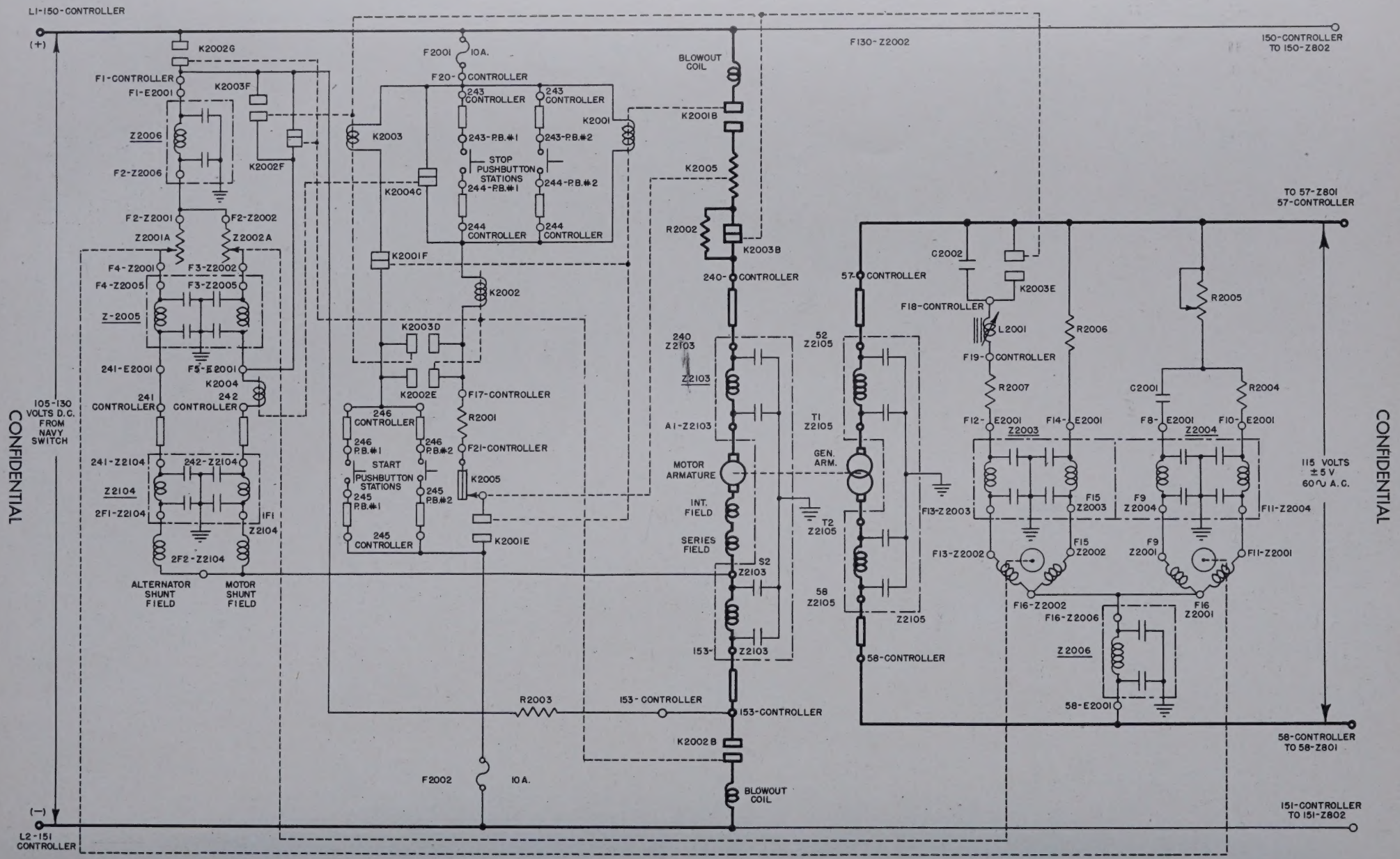
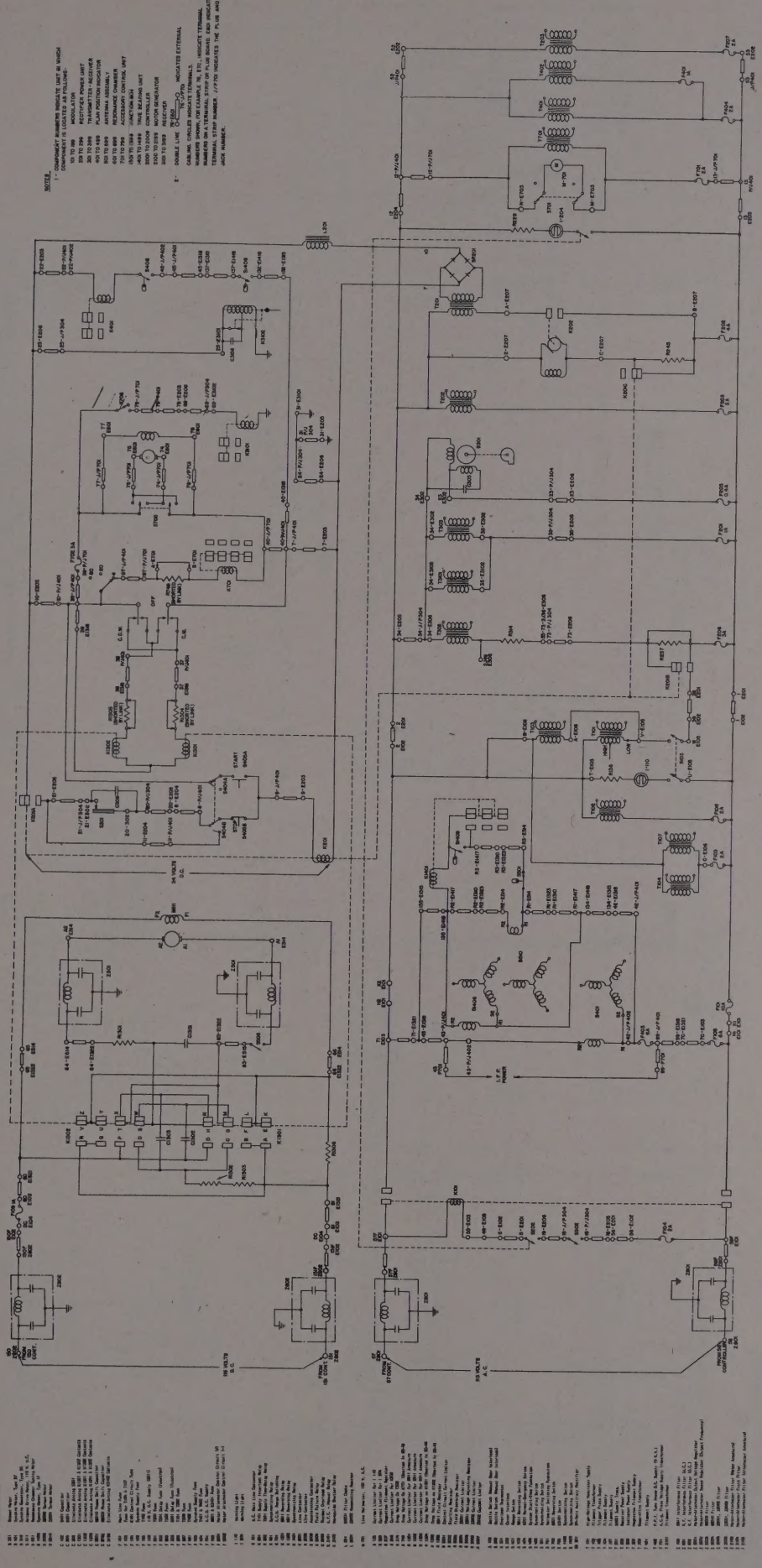


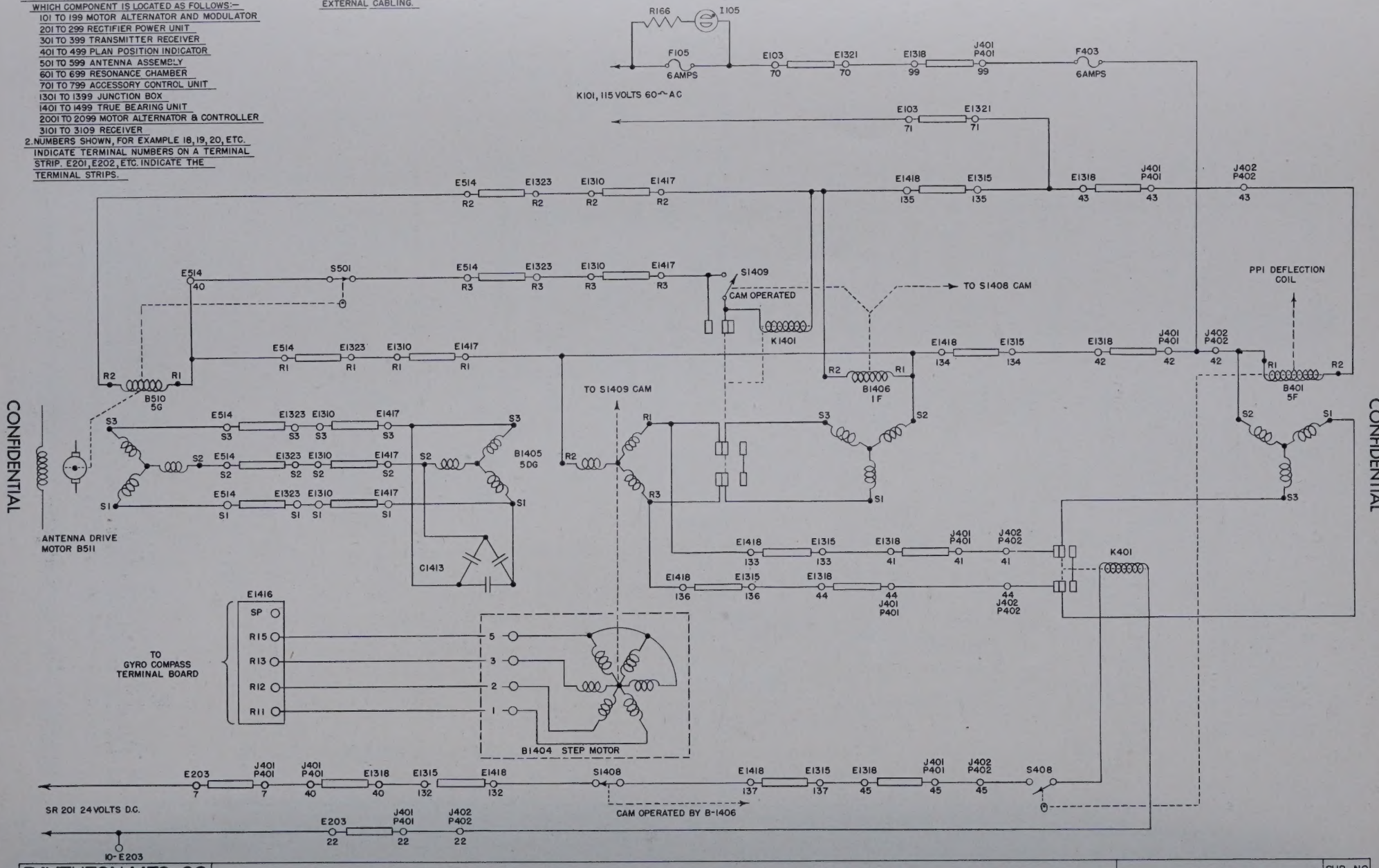
RAYTHEON MFG. CO. WALTHAM, MASS.	PRIMARY POWER BREAKDOWN-SO-4 SHEET I POWER SOURCE	W-9J-8	SUB NO. 0



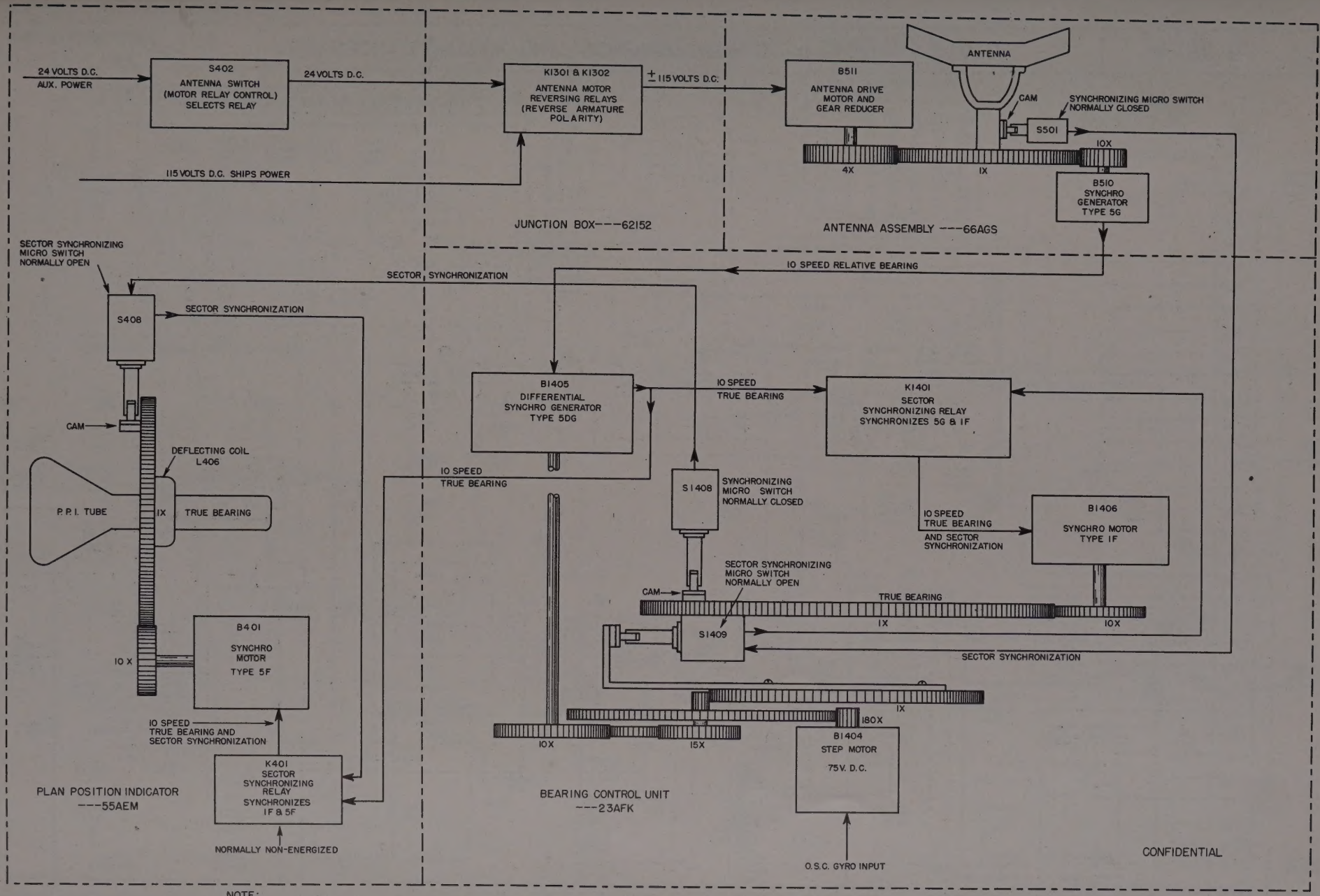
RAYTHEON MFG. CO. WALTHAM, MASS.	PRIMARY POWER BREAKDOWN - SO-4 SHEET 2 POWER FLOW	W-9J-8 SHEET 2	SUB NO. 0

LEGEND:

1. COMPONENT NUMBERS INDICATE UNIT IN WHICH COMPONENT IS LOCATED AS FOLLOWS:—
   - 101 TO 199 MOTOR ALTERNATOR AND MODULATOR
   - 201 TO 299 RECTIFIER POWER UNIT
   - 301 TO 399 TRANSMITTER RECEIVER
   - 401 TO 499 PLAN POSITION INDICATOR
   - 501 TO 599 ANTENNA ASSEMBLY
   - 601 TO 699 RESONANCE CHAMBER
   - 701 TO 799 ACCESSORY CONTROL UNIT
   - 1301 TO 1399 JUNCTION BOX
   - 1401 TO 1499 TRUE BEARING UNIT
   - 2001 TO 2099 MOTOR ALTERNATOR & CONTROLLER
   - 3101 TO 3109 RECEIVER
2. NUMBERS SHOWN, FOR EXAMPLE 18, 19, 20, ETC. INDICATE TERMINAL NUMBERS ON A TERMINAL STRIP. E201, E202, ETC. INDICATE THE TERMINAL STRIPS.
3. DOUBLE LINE ⟨═══⟩ INDICATES EXTERNAL CABLING.



RAYTHEON MFG. CO. WALTHAM, MASS.	SO-4 SYNCHRO SYSTEM SCHEMATIC	W-9J-3	SUB NO 1



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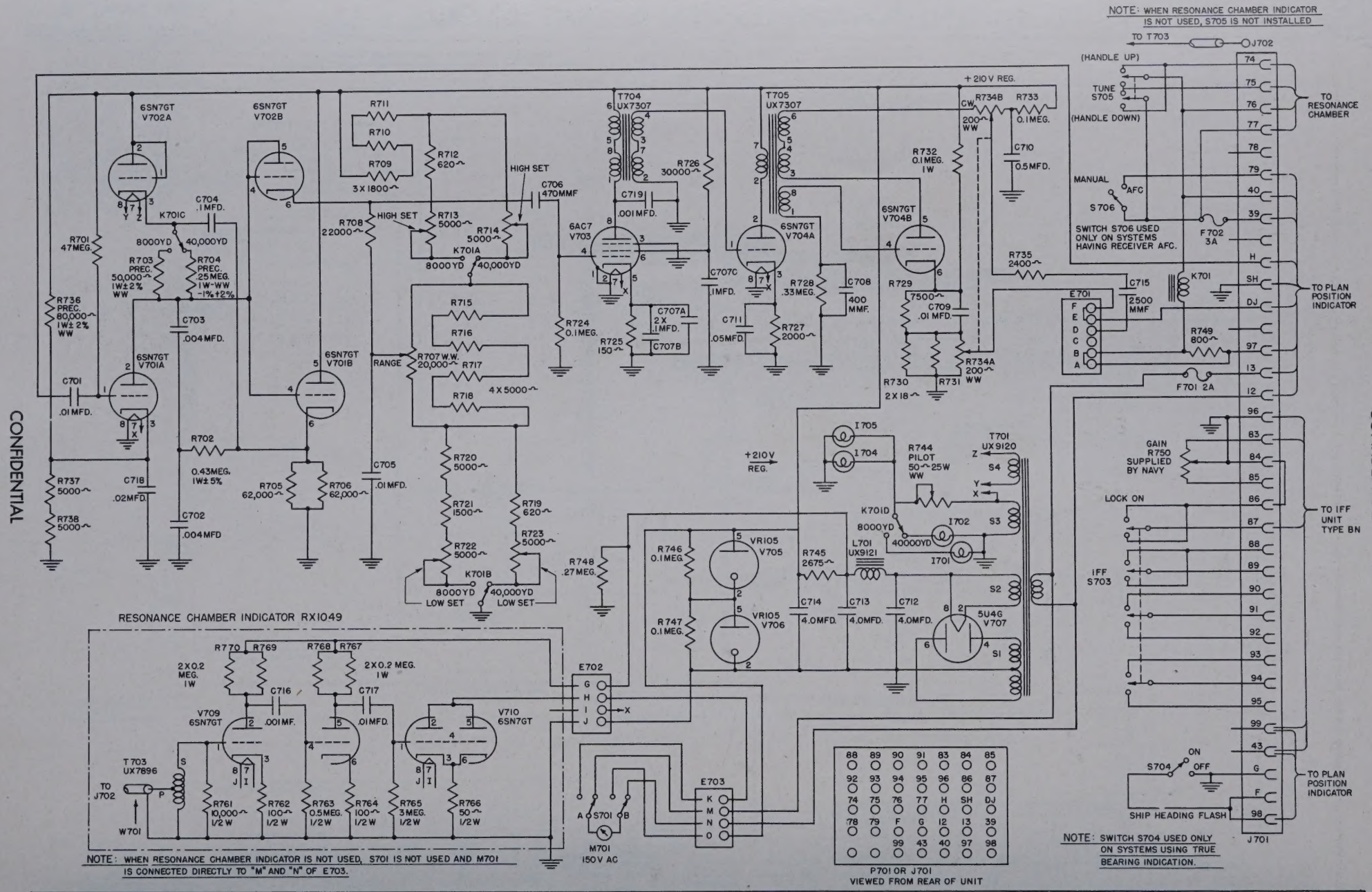
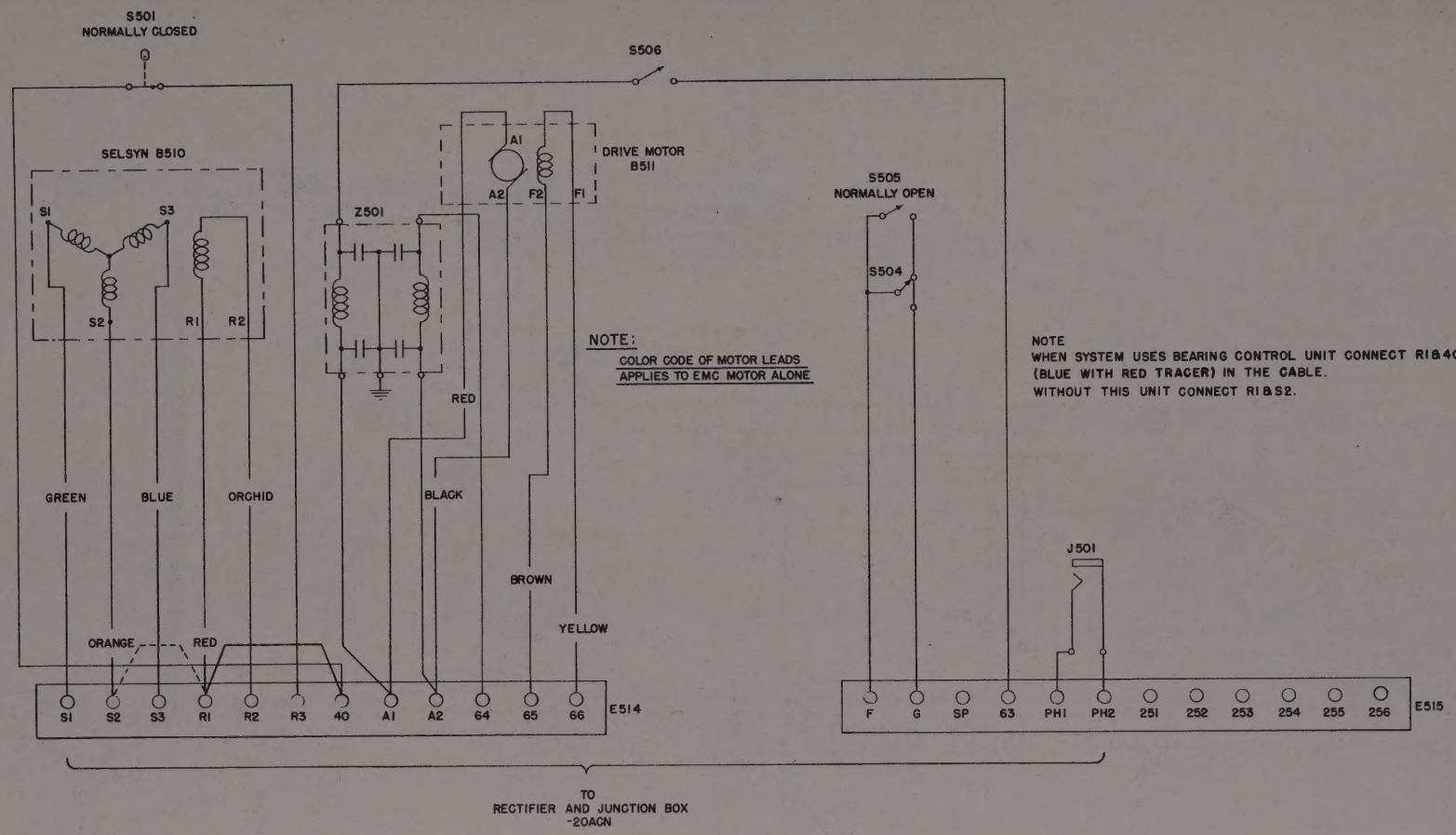
NOTE:
NUMERAL NEAR GEAR INDICATES MULTIPLE OF ANTENNA SPEED.
FOR EXAMPLE, 4X INDICATES 4 TIMES ANTENNA SPEED.

RAYTHEON MFG. CO. WALTHAM, MASS.	SO-4 SYNCHRO SYSTEM BLOCK DIAGRAM WITH B.C.U.	W-9J-6	SUB NO. 0



RAYTHEON MFG. CO. WALTHAM, MASS.	ACCESSORY CONTROL UNIT SCHEMATIC FOR SO-4 RADAR ---23AFD	W-9K-6	SUB NO. 6

CONFIDENTIAL



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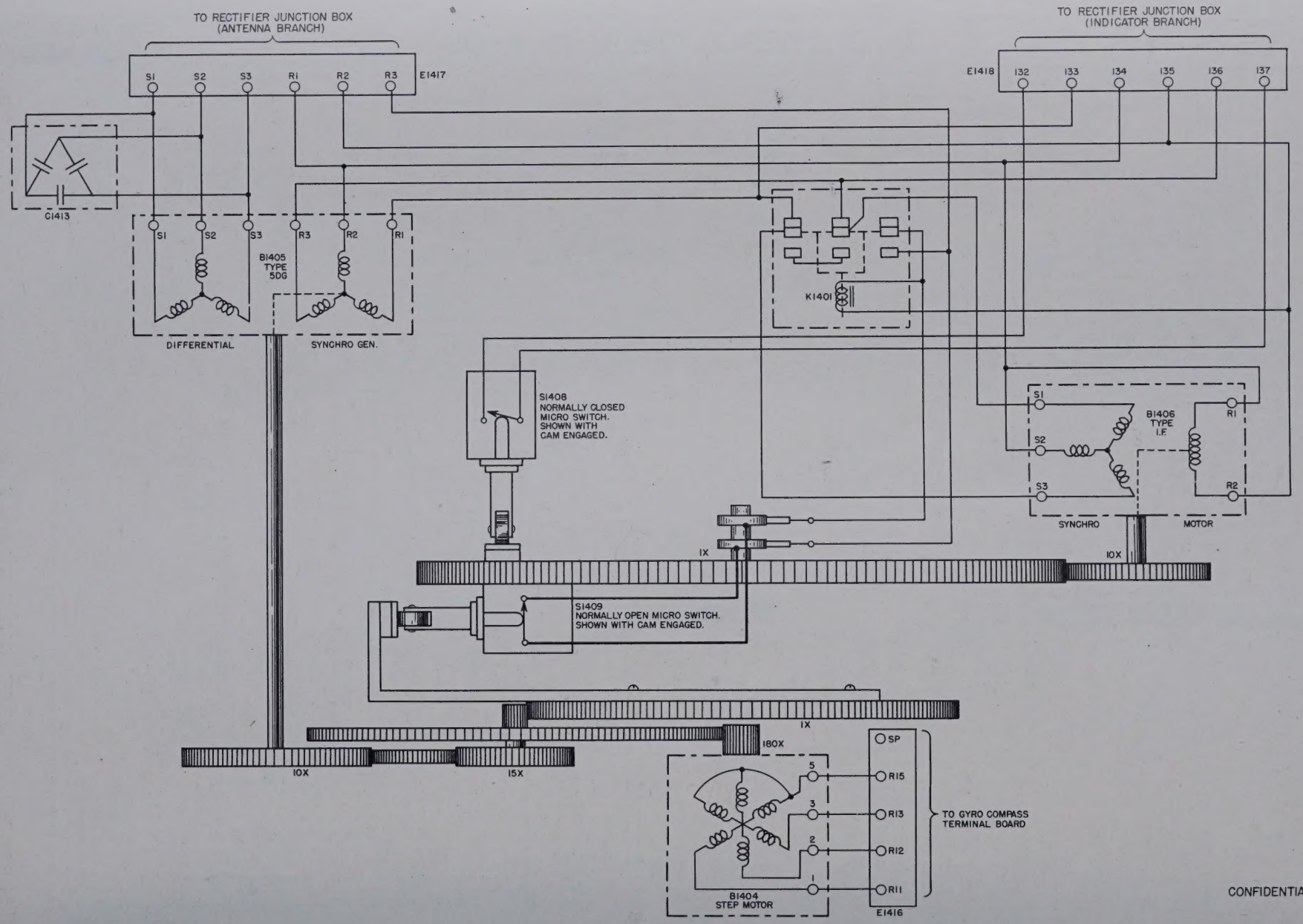
RAYTHEON MFG. CO. WALTHAM, MASS.	SO-4 ANTENNA SCHEMATIC	W-9A-1	SUB NO. 6



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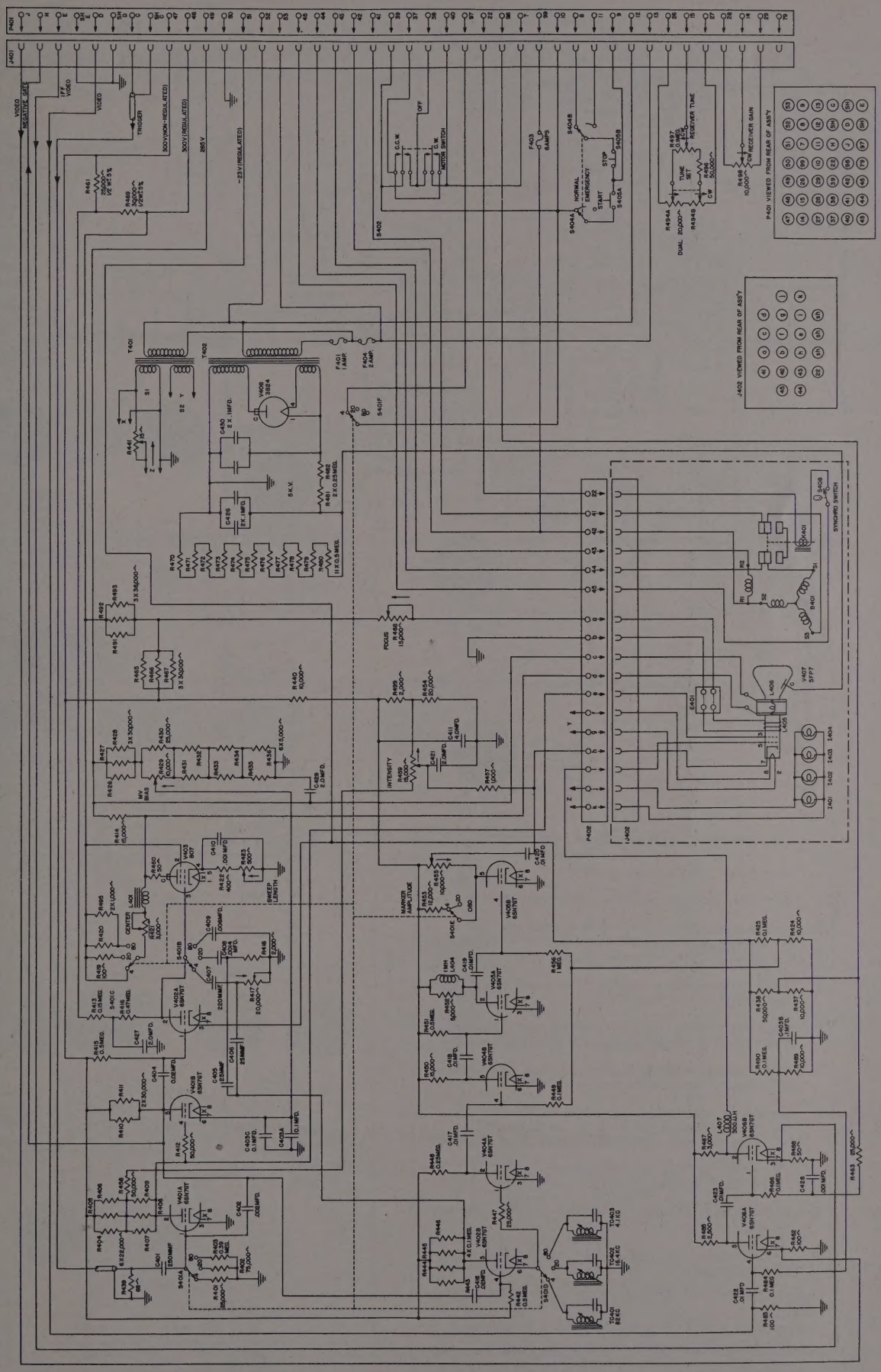
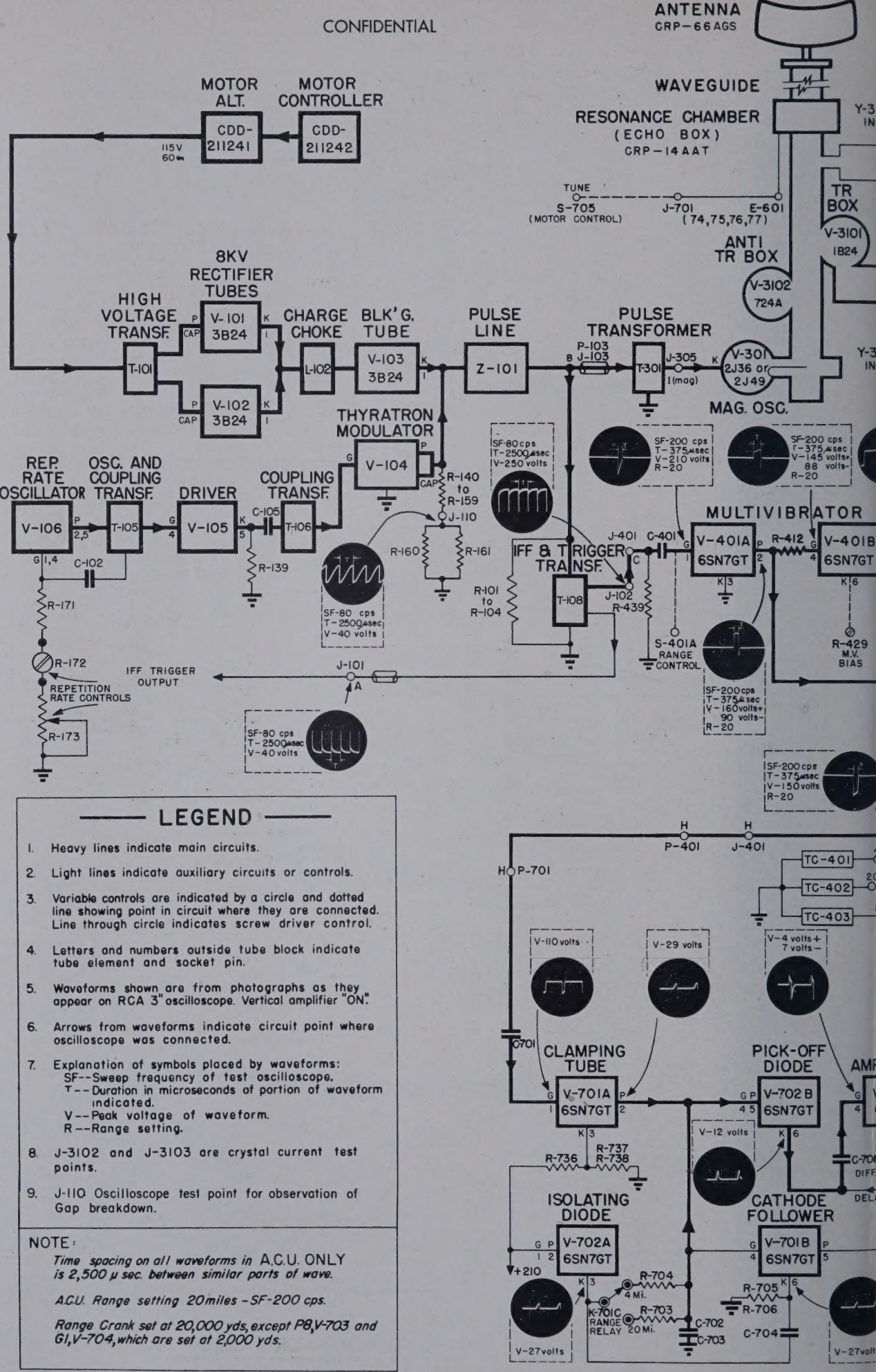
RAYTHEON MFG. CO. WALTHAM, MASS.	BEARING CONTROL UNIT ---23AFK	W-9S-1	SUB NO. 5



RAYTHEON MFG. CO. WALTHAM, MASS.	SCHEMATIC PLAN POSITION INDICATOR---55AEM	W-34C-20	SUB NO. 8



LEGEND

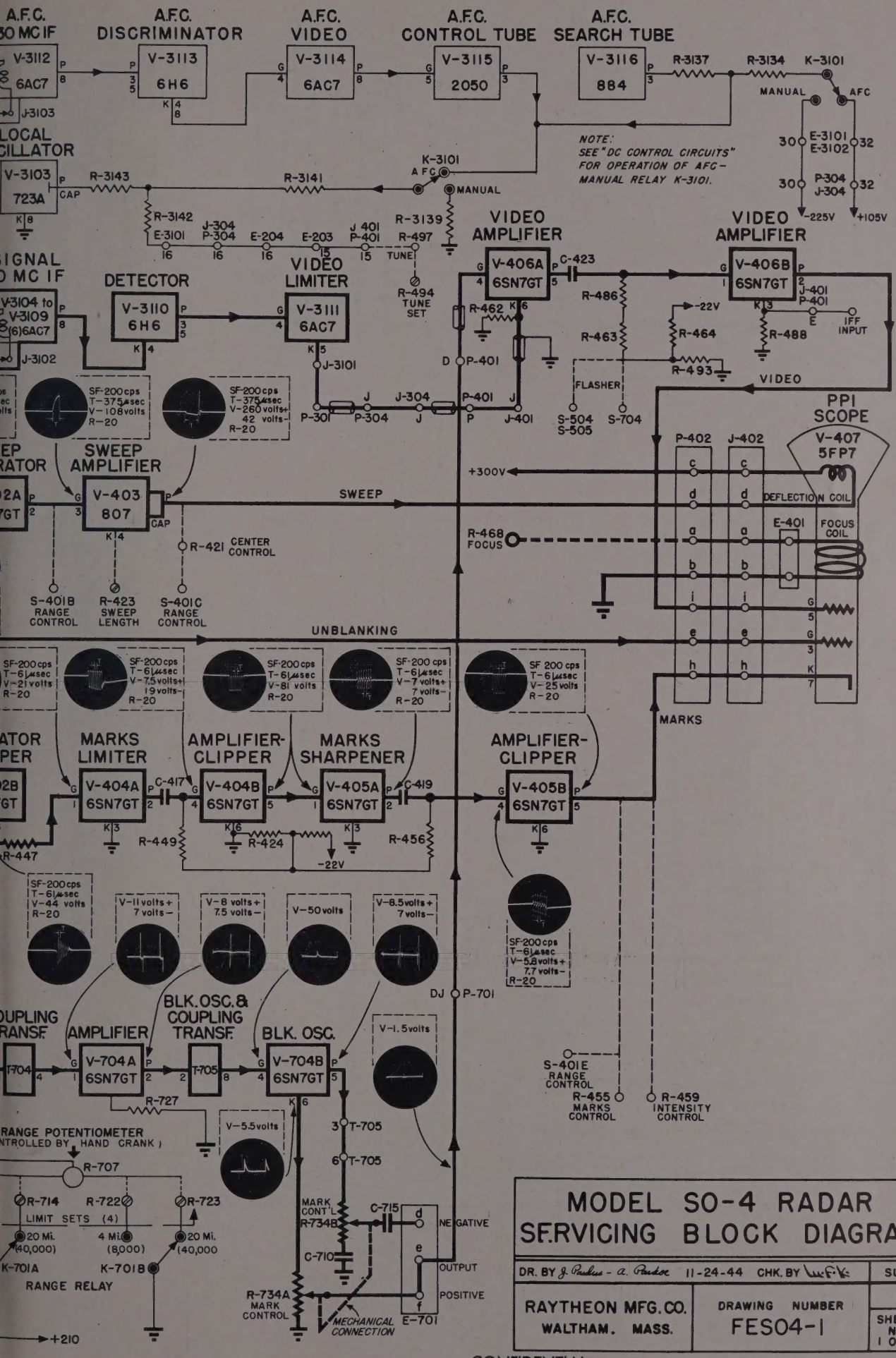
1. Heavy lines indicate main circuits.
2. Light lines indicate auxiliary circuits or controls.
3. Variable controls are indicated by a circle and dotted line showing point in circuit where they are connected. Line through circle indicates screw driver control.
4. Letters and numbers outside tube block indicate tube element and socket pin.
5. Waveforms shown are from photographs as they appear on RCA 3" oscilloscope. Vertical amplifier "ON".
6. Arrows from waveforms indicate circuit point where oscilloscope was connected.
7. Explanation of symbols placed by waveforms:
   SF--Sweep frequency of test oscilloscope.
   T--Duration in microseconds of portion of waveform indicated.
   V--Peak voltage of waveform.
   R--Range setting.
8. J-3102 and J-3103 are crystal current test points.
9. J-110 Oscilloscope test point for observation of Gap breakdown.

NOTE:

Time spacing on all waveforms in A.C.U. ONLY is 2,500 μ sec. between similar parts of wave.

A.C.U. Range setting 20 miles - SF-200 cps.

Range Crank set at 20,000 yds, except P8, V-703 and G1, V-704, which are set at 2,000 yds.



MODEL SO-4 RADAR SERVICING BLOCK DIAGRAM

DR. BY J. Parkes - A. Parker 11-24-44 CHK. BY		SUB 1
RAYTHEON MFG. CO. WALTHAM. MASS.	DRAWING NUMBER FES04-1	SHEET NO. 1 OF 2

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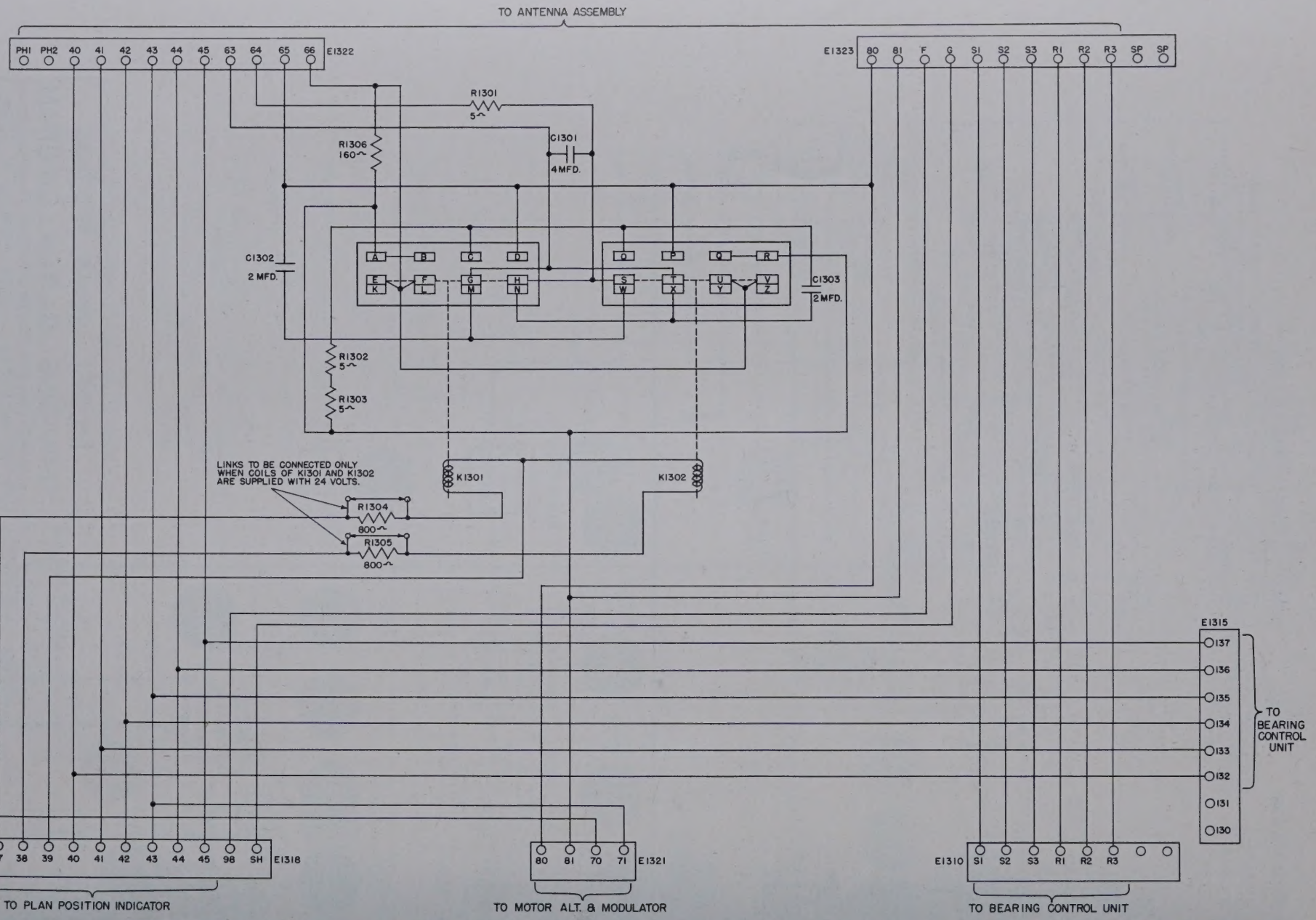
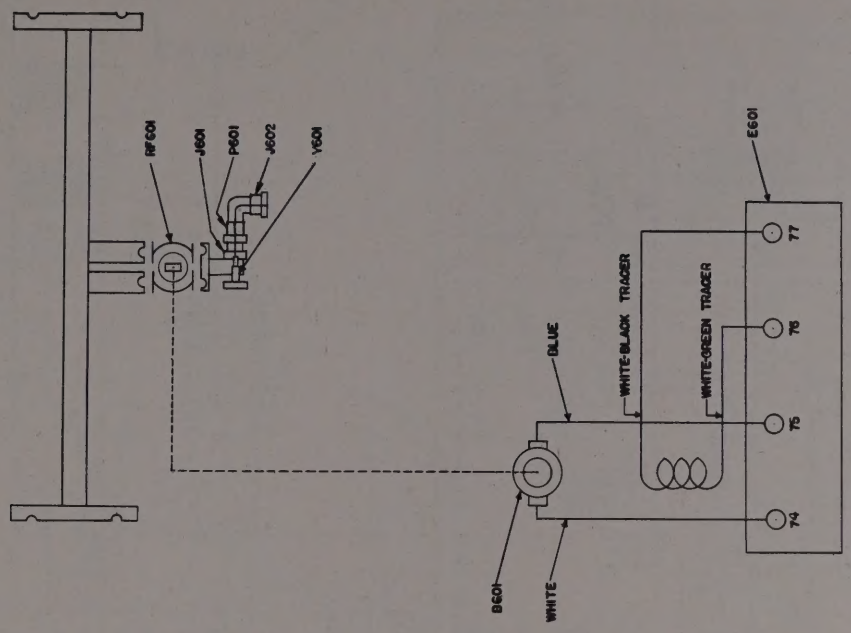
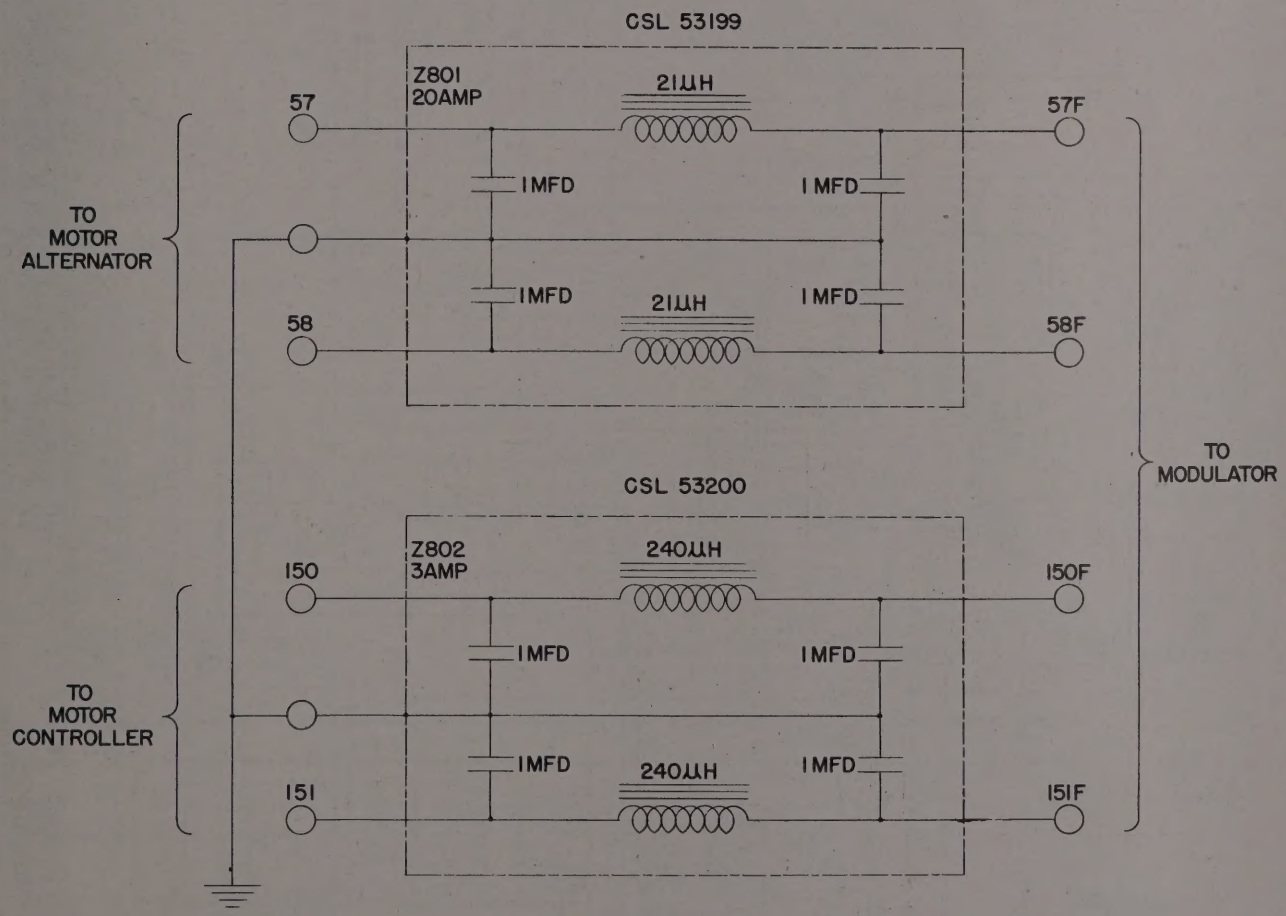

TO ANTENNA ASSEMBLY
PH1 PH2 40 41 42 43 44 45 63 64 65 66 E1322
E1323 80 81 F G S1 S2 S3 R1 R2 R3 SP SP
R1301 5Ω
R1306 160Ω
C1301 4MFD.
C1302 2 MFD.
C1303 2MFD.
A B C D E K F L G M H N
Q P Q R S W T X U Y V Z
R1302 5Ω
R1303 5Ω
LINKS TO BE CONNECTED ONLY WHEN COILS OF K1301 AND K1302 ARE SUPPLIED WITH 24 VOLTS.
K1301
K1302
R1304 800Ω
R1305 800Ω
E1315
137
136
135
134
133
132
131
130
TO BEARING CONTROL UNIT
99 37 38 39 40 41 42 43 44 45 98 SH E1318
80 81 70 71 E1321
E1310 S1 S2 S3 R1 R2 R3
TO PLAN POSITION INDICATOR
TO MOTOR ALT. & MODULATOR
TO BEARING CONTROL UNIT

RAYTHEON MFG. CO. WALTHAM, MASS.	SCHEMATIC SO-4 JUNCTION BOX	W-9E-1	SUB NO. 1



RAYTHEON MFG.CO. WALTHAM, MASS.	SCHEMATIC-RESONANCE CHAMBER 14AAT	W-5E15- 68	SUB D



RAYTHEON MFG. CO. WALTHAM, MASS.	LINE FILTER---53198	W-9R-9	SUB NO. D

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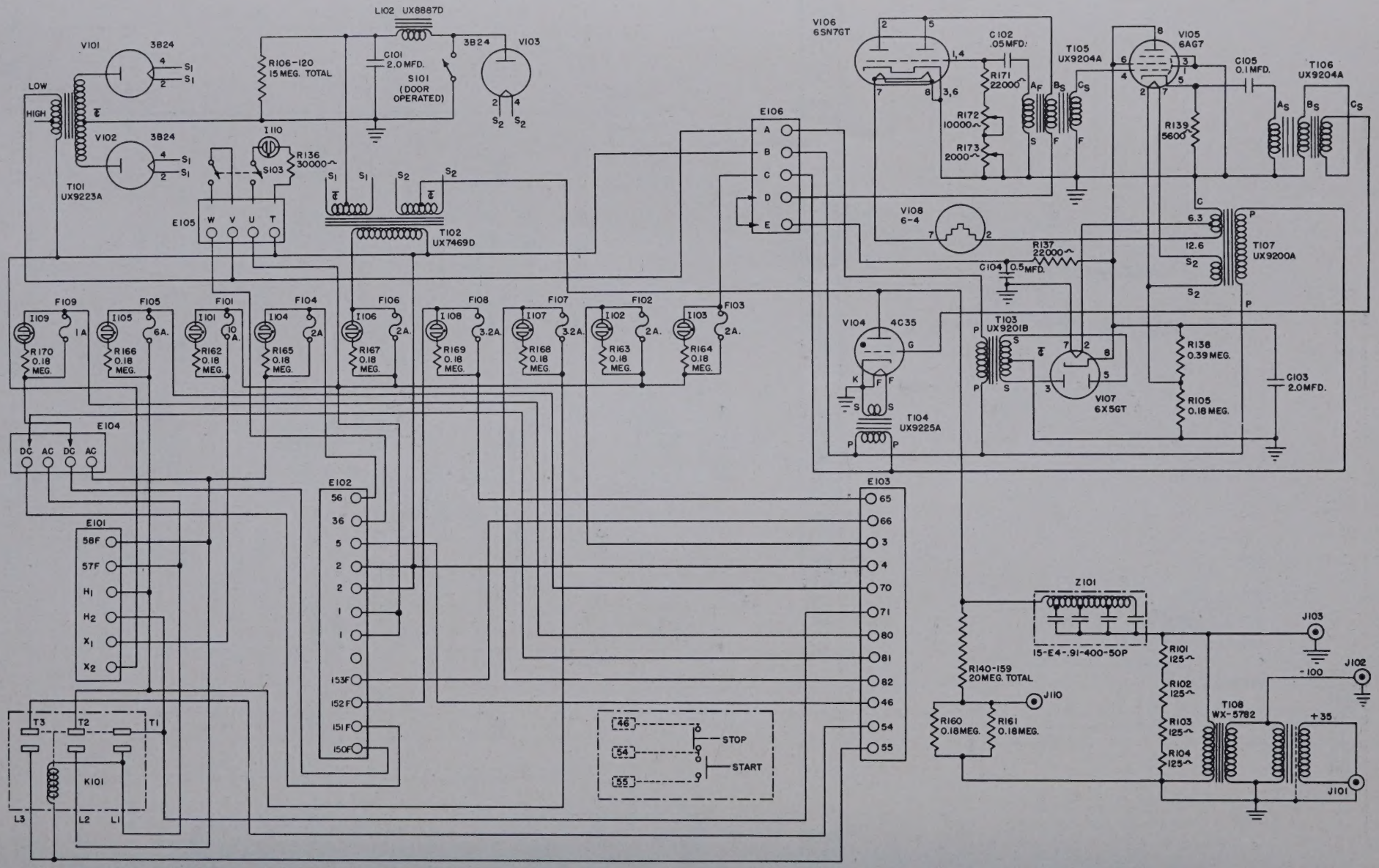

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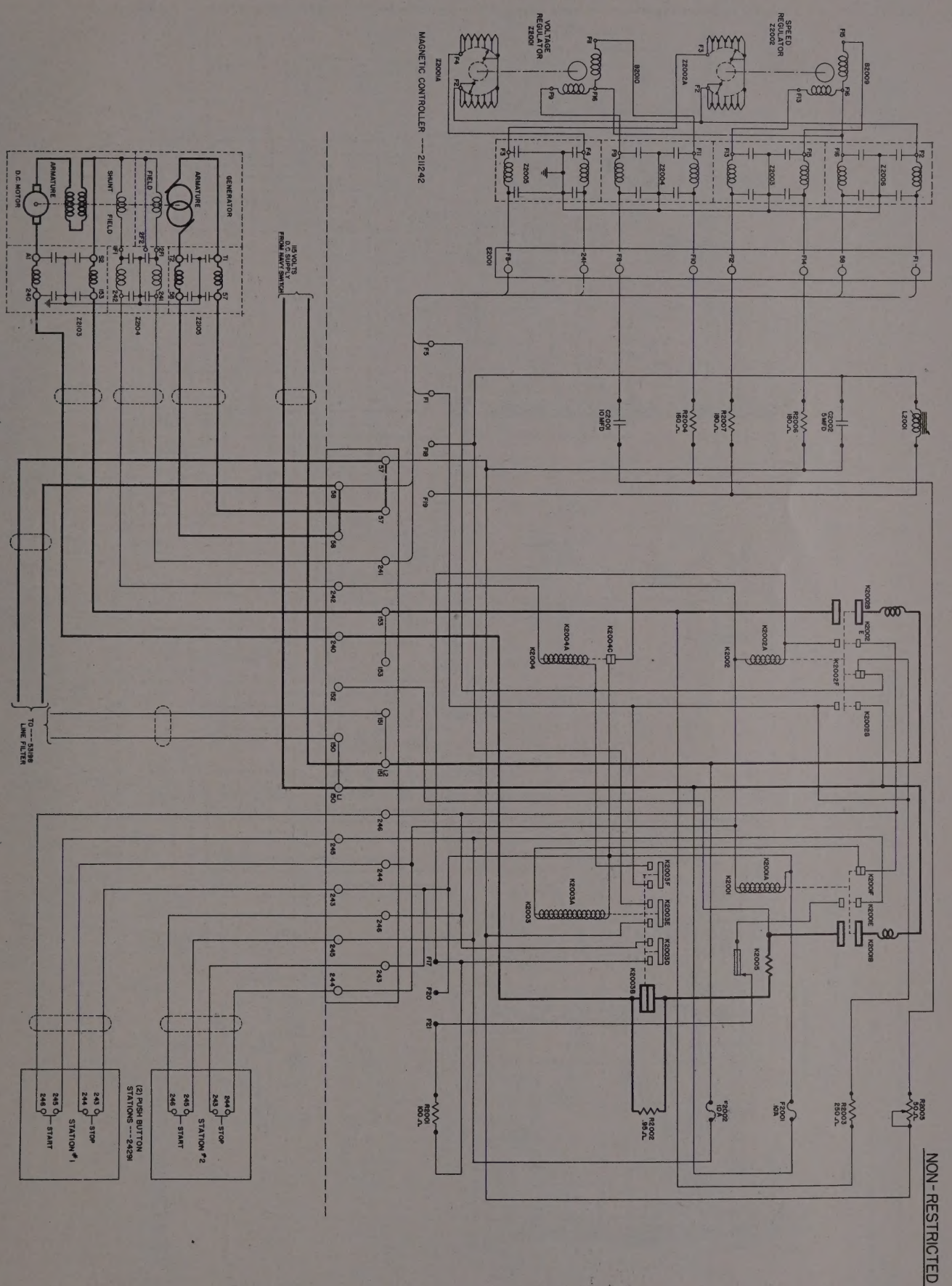
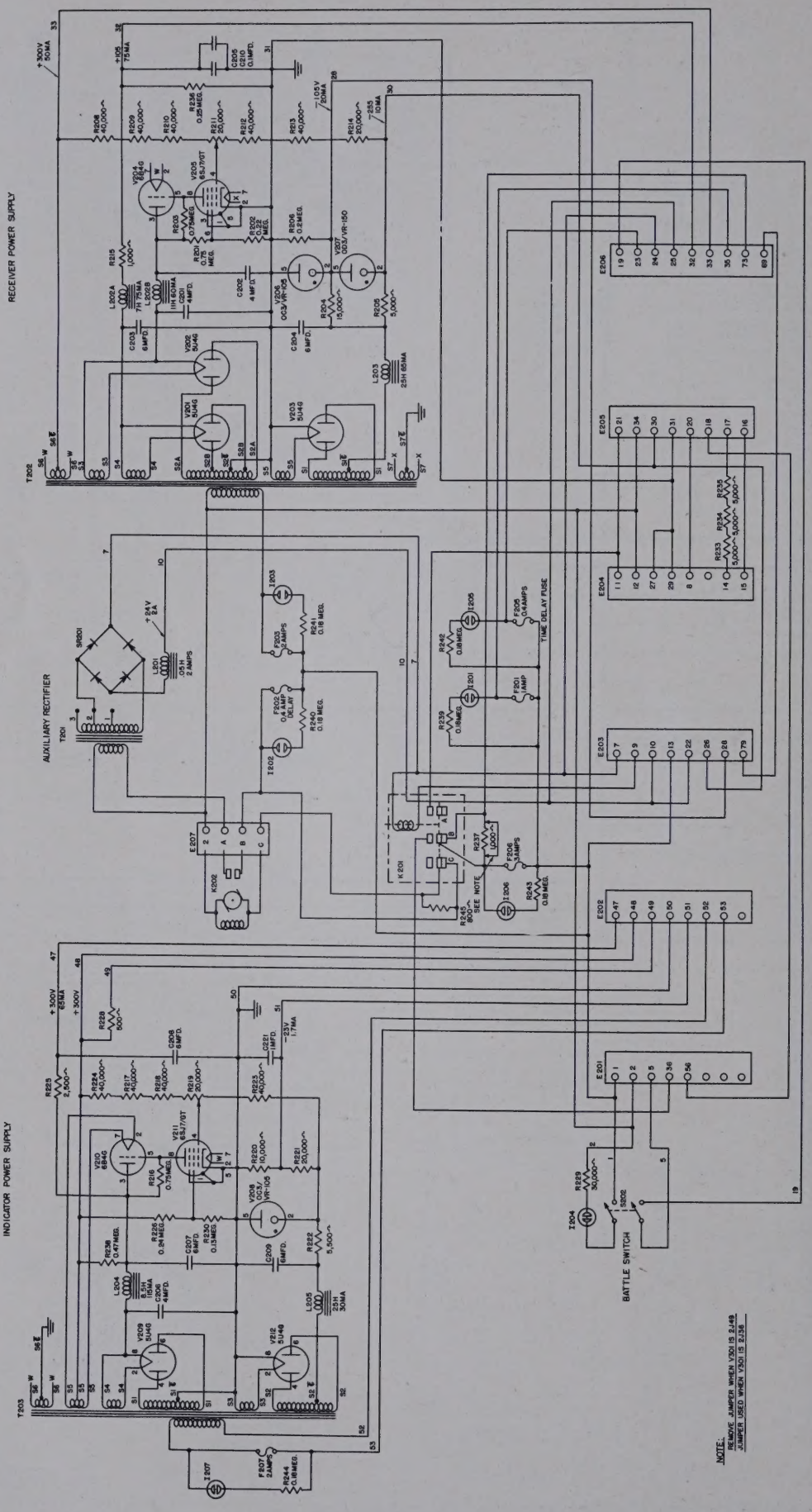
RAYTHEON MFG. CO. WALTHAM, MASS.	SCHEMATIC-MODULATOR FOR SO-4 RADAR	W-9 D-2	SUB NO. 7



RAYTHEON MFG. CO. WALTHAM, MASS.	SCHEMATIC MOTOR GEN.---211241, CONTROLLER---211242, P.B.STA'S.---24291	W-71A-6	SUB NO. 2



RAYTHEON MFG. CO. WALTHAM, MASS.	RECTIFIER POWER UNIT SCHEMATIC - 20ACU-20ADE	W-36F-1	SUB NO. 30

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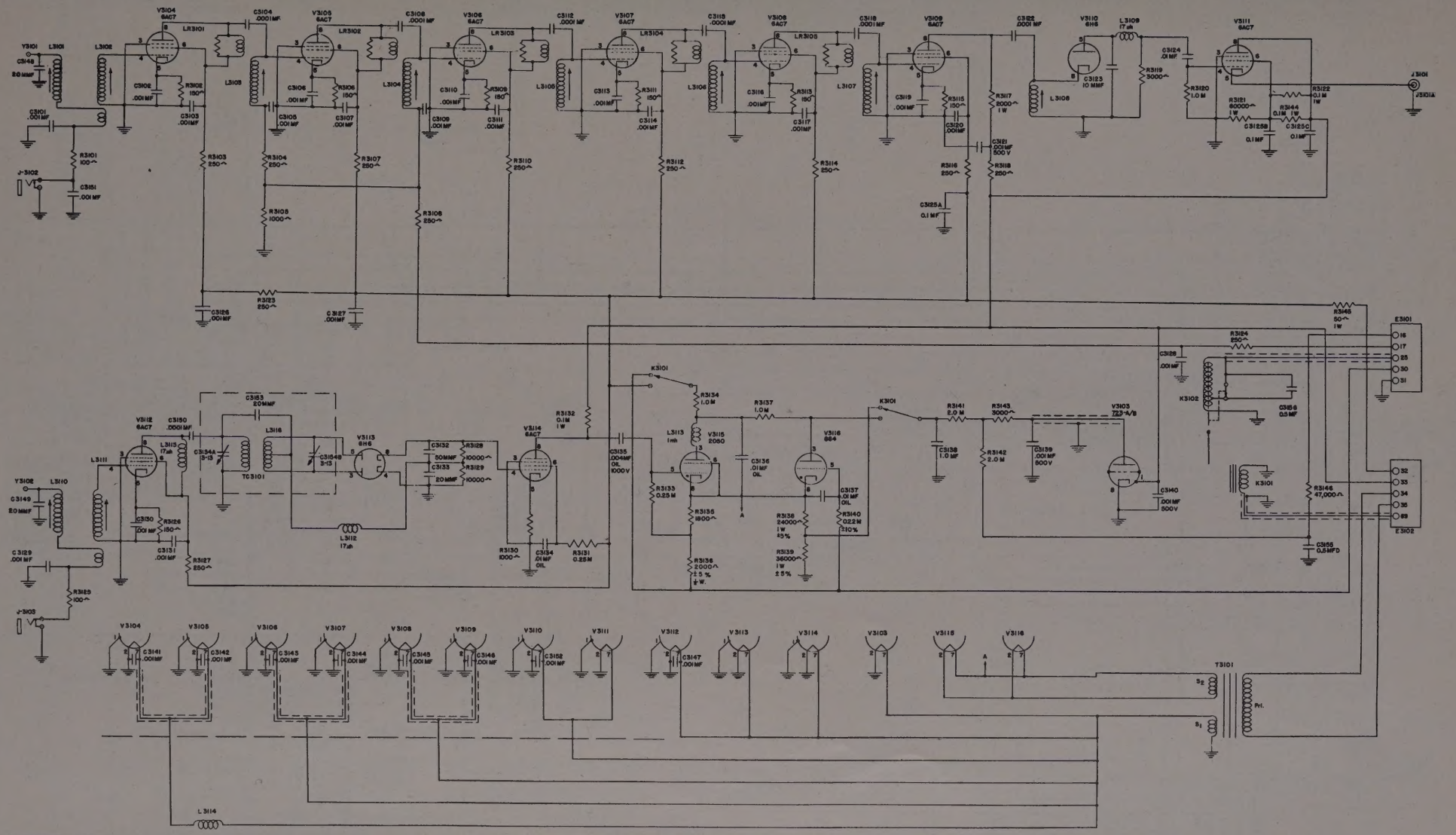

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RAYTHEON MFG. CO. WALTHAM, MASS.	-46ADA RECEIVER SCHEMATIC	W-5B-2	SUB V

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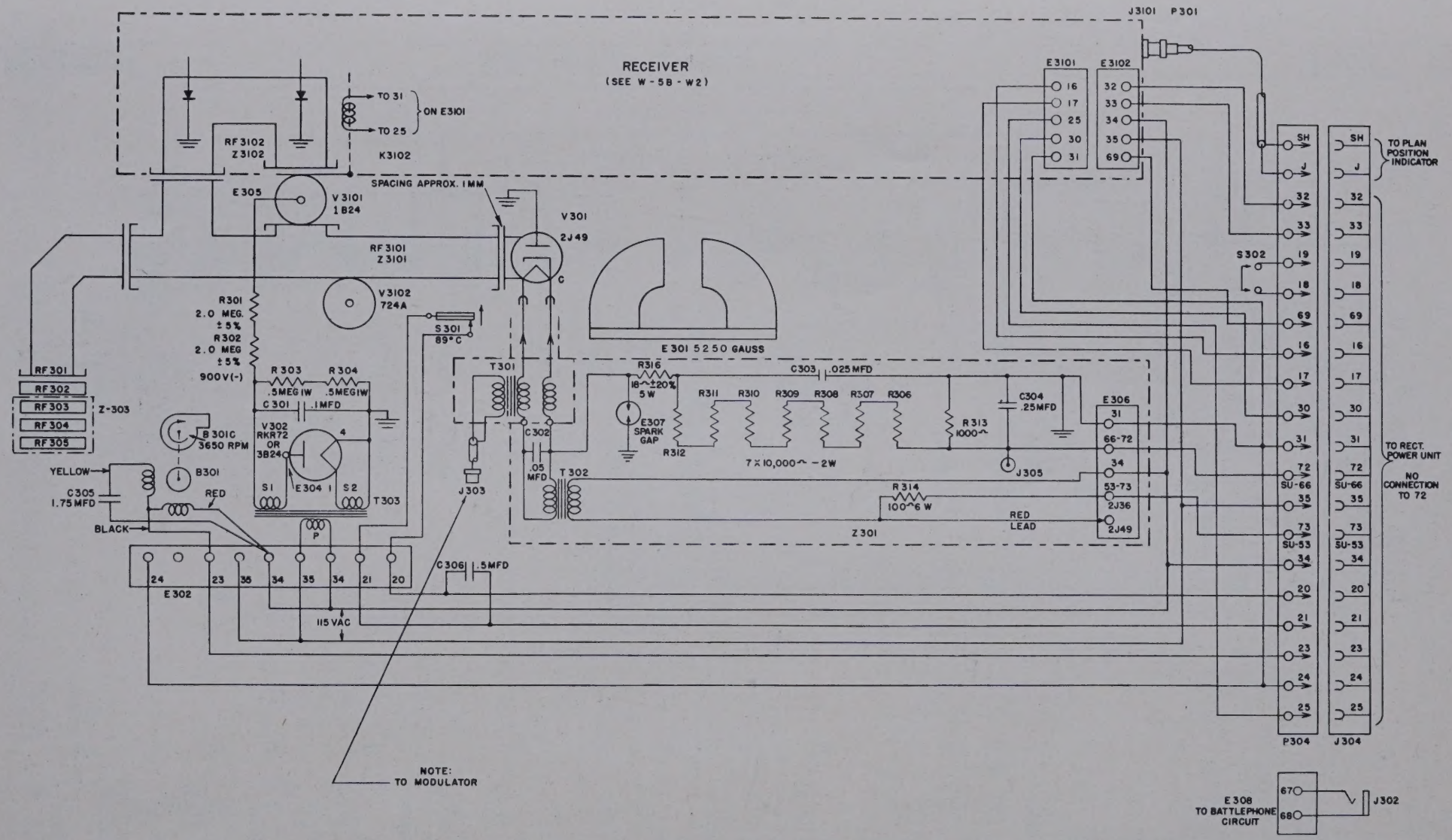

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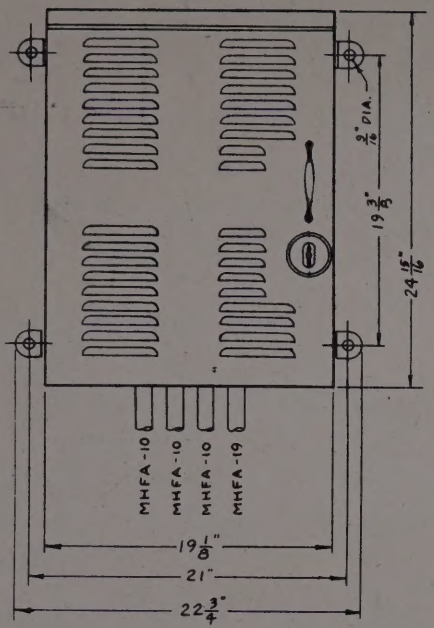
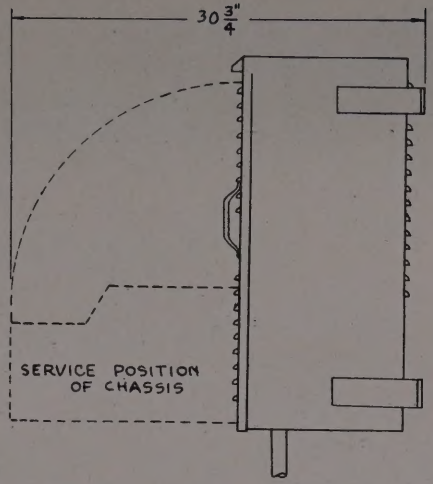
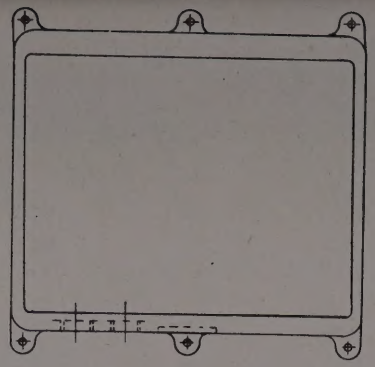
RAYTHEON MFG. CO. WALTHAM, MASS.	RF PACKAGE-TRANS. RECEIVER SO-4, SO-12 SCHEMATIC	W-9B7-8	SUB K

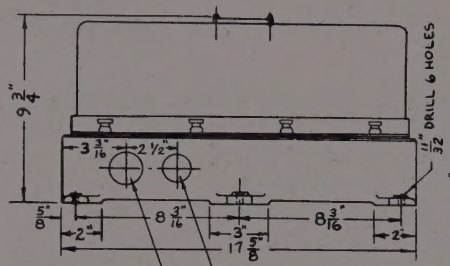


OUTLINE RECT. POWER UNIT- SO-4
CRP-20ACU



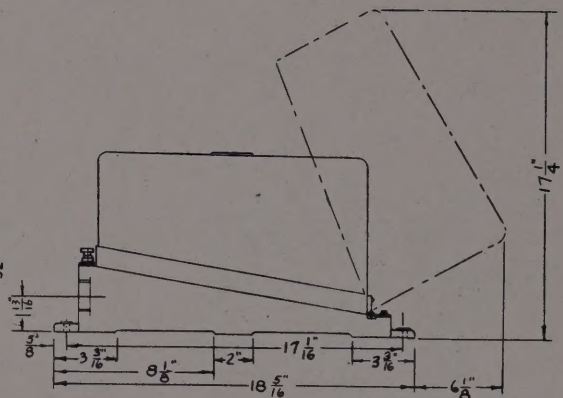
148 # APPROX. WGT.





1 1/4"-11 1/2" THDS. PER IN. PIPE TAP
1"-11 1/2" THDS. PER IN. PIPE TAP

SO-4 BEARING CONTROL UNIT
CRP-23AFK



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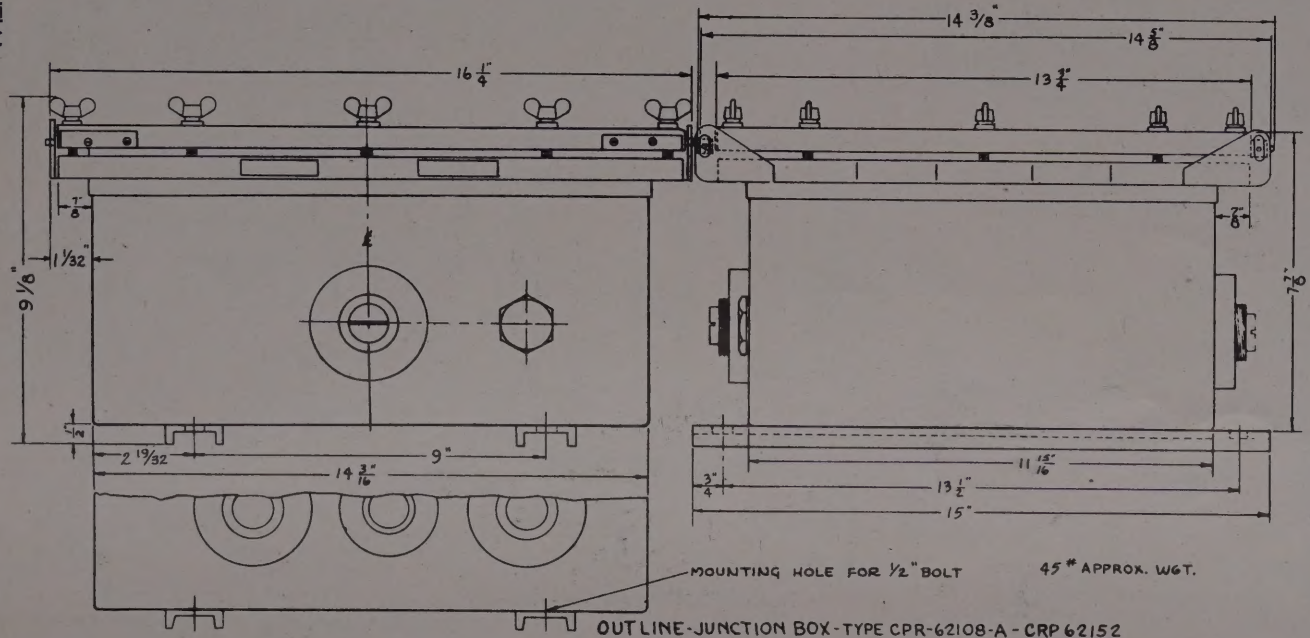

45 # APPROX. WGT.

OUTLINE-JUNCTION BOX-TYPE CPR-62108-A - CRP 62152

NOTE- ADAPTED FROM BUREAU OF SHIPS DWG # AS NOTED.

RADIO DIVISION	BUREAU OF SHIPS
NAVY DEPARTMENT	WASHINGTON, D. C.

MODEL SO-4 OUTLINE & MOUNTING DIMENSIONS

SCALE NONE DATE 9-5-44

RE43 F362A

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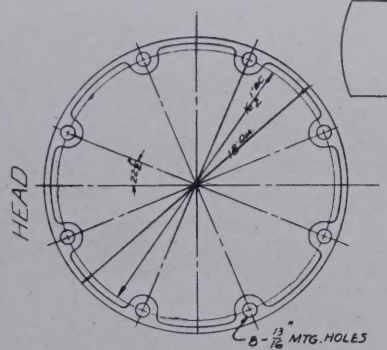
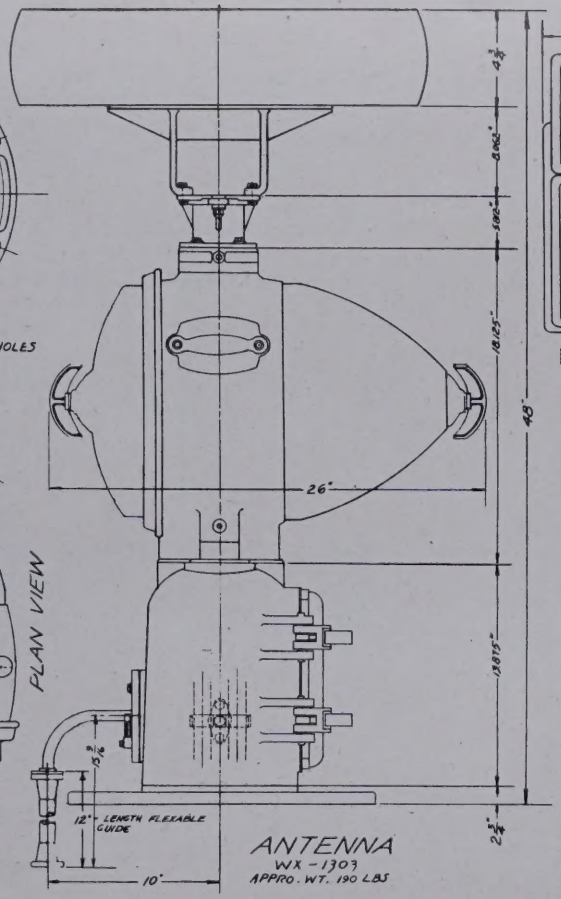
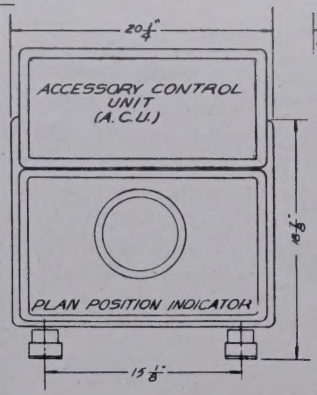
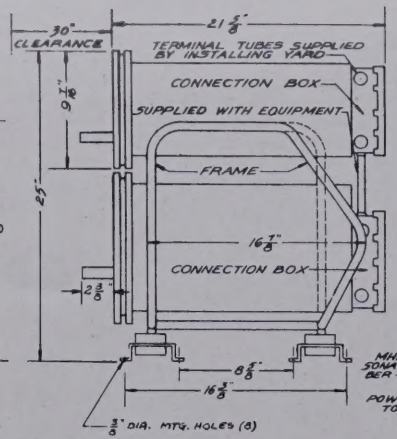




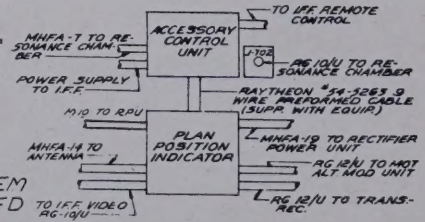
ANTENNA
WX-1303
APPRO. WT. 190 LBS



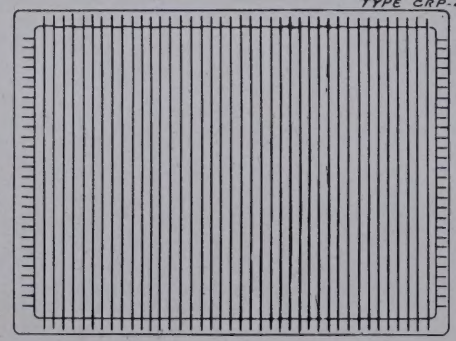


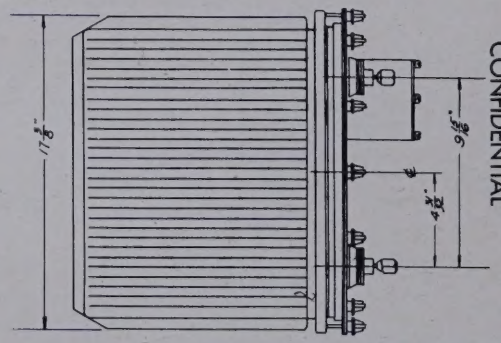
ASSEMBLY
WT. 145 LBS
PLAN POSITION INDICATOR TYPE CRP 55AEM
ACCESSORY CONTROL UNIT TYPE CRP 23AFD
MOUNTING FRAME TYPE CRP-10252

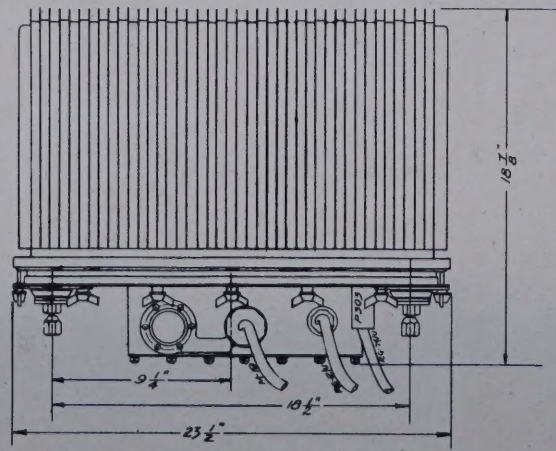
CONNECTION BOXES
(VIEWED FROM REAR)

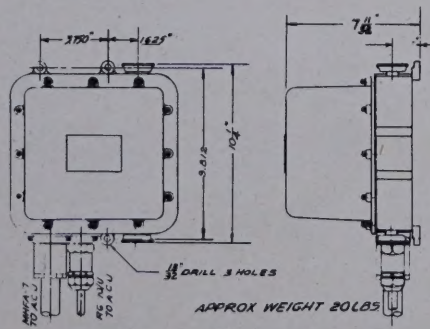

ACCESSORY CONTROL UNIT
PLAN POSITION INDICATOR
TO I.F.F. REMOTE CONTROL
MIHFA-7 TO RESONANCE CHAMBER
RG 10/U TO RESONANCE CHAMBER
POWER SUPPLY TO I.F.F.
RAYTHEON #54-1263 9 WIRE PREFORMED CABLE (SUPR WITH EQUIP.)
MI-10 TO RPU
MIHFA-14 TO ANTENNA
MIHFA-10 TO RECTIFIER POWER UNIT
RG 12/U TO MOT ALT MOD UNIT
TO I.F.F. VIDEO RG-10/U
RG 12/U TO TRANS.-REC.

TRANS.-RECEIVER
TYPE CRP-43 ACN APPROX WT. 134#





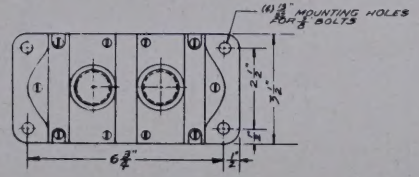


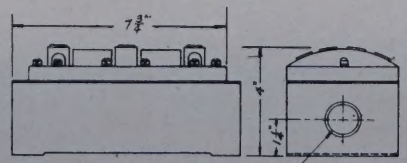


APPROX WEIGHT 20 LBS

OUTLINE-504-RESONANCE CHAMBER
TYPE CRP-14AAT

PUSH BUTTON STATION
UNIT WEIGHT 3 1/2 LBS.





NOTE- ADAPTED FROM BUREAU OF SHIPS DWG. NO. AS NOTED

RADIO DIVISION	BUREAU OF SHIPS
NAVY DEPARTMENT	WASHINGTON, D. C.

MODEL SO-4 OUTLINE & MOUNTING DIMENSIONS

SCALE | DATE SEPT. 1, 1944

RE 43F 362A

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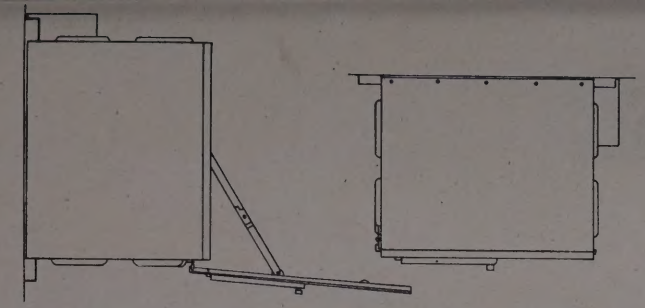
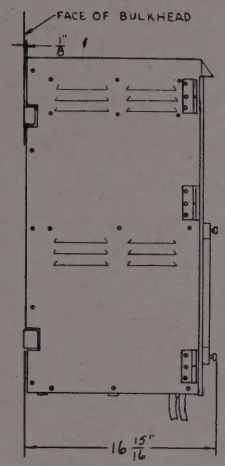
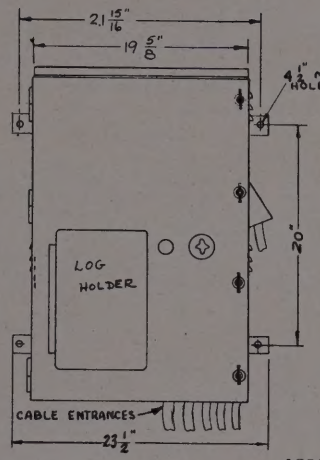
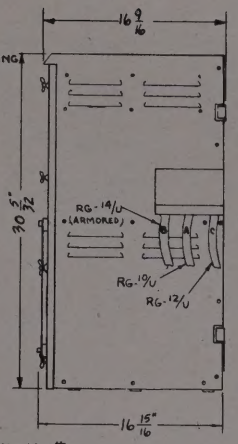


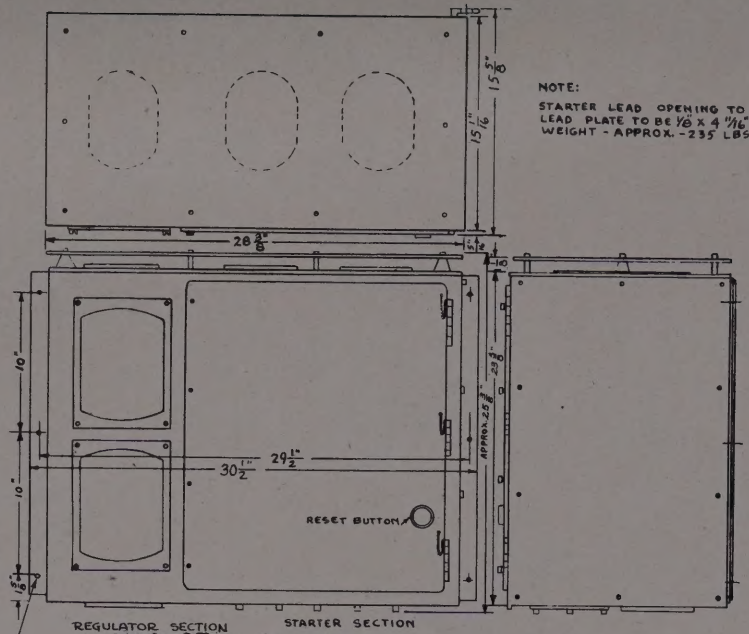






APPROX. WGT. 185 #

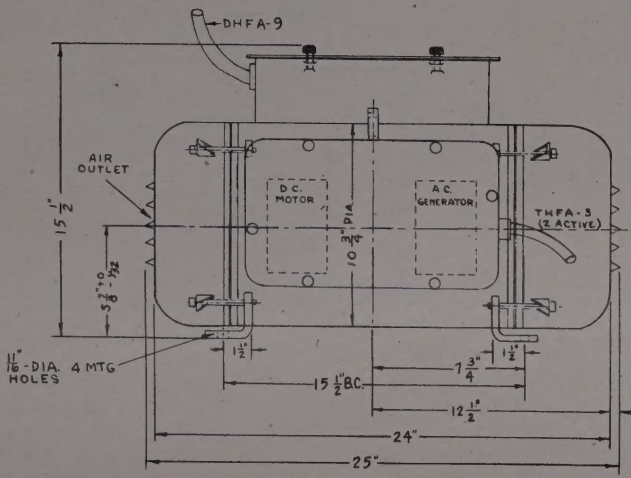
OUTLINE MODULATOR
CRP-50AEQ

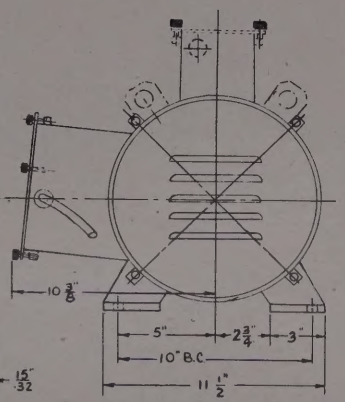


NOTE:
STARTER LEAD OPENING TO BE 4 1/16" X 10" LG.
LEAD PLATE TO BE 1/8 X 4 1/16" X 10 5/8" LG
WEIGHT - APPROX. - 235 LBS.

(6) 9/16" DIA. MTG. HOLES

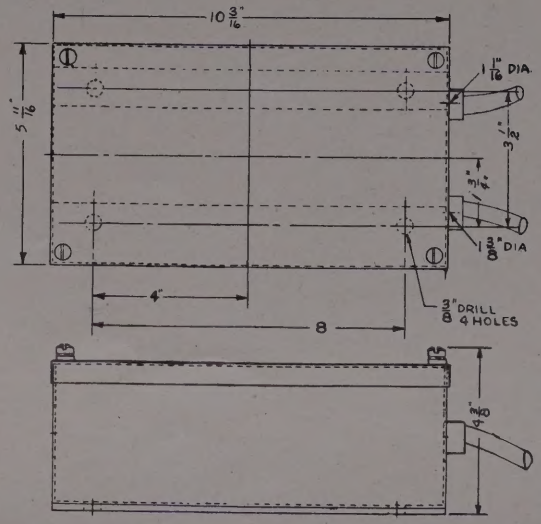
MAGNETIC CONTROLLER
CDD - 211242





APPROX. WGT 280 #

MOTOR ALTERNATOR
CDD - 211241



APPROX. WGT. 25 #

RF FILTER - ASSEMBLY
CRP 53198

NOTE: ADAPTED FROM BUREAU OF SHIPS DWG. NO. A3 NOTED

RADIO DIVISION	BUREAU OF SHIPS
NAVY DEPARTMENT	WASHINGTON, D. C.

MODEL SO-4
OUTLINE & MOUNTING DIMENSIONS

SCALE NONE DATE 9-11-44

RE 43 F362

R. I. P. CHANGE No. 59

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